

Proforma of information to be collected for the University departments for uploading on the University website

**1. A. Name of the Department/Section: AQUACULTURE
B. About department**

This department aims at developing the manpower required for the evergrowing aquaculture industry. The scientists from this department are actively engaged in finding scientific methods to produce better fish and shellfish varieties, improved fish feeds and aquaculture techniques that could be easily adopted by the fish farmers. The “lab to land” programmes are implemented with vigor and enthusiasm by the students of this department through the hands on training and experiential learning programme.



C.Academic Programmes:

a. Doctoral Programmes

1. Name of the programme: Aquaculture

Major Courses:

Course Code	Semester	Course Title	Credits 12
AQC 601	I	Hi-tech Aquaculture Production Systems	2+1
AQC 602	I	Seed Production and Hatchery Management	2+1
AQC 603	II	Aquaculture Ecosystem Management and Climate Change	2+1

AQC 604	II	Fish and Shellfish Physiology and Endocrinology	2+1
AQC 691	III	Doctoral Seminar I	0+1
AQC 691	IV	Doctoral Seminar II	0+1
		Total	8+6 =14
AQC 699	II to VI	Doctoral Research	0+75

Minor Courses

(These are the suggestive courses from the subjects closely related to a student's major subject)

Course Code	Semester	Course Title	Credits
AQC 605	I	Feed Management in Aquaculture	1+1
AQC 606	I	Applied Biotechnology in Aquaculture	1+1
AQC 607	II	Automation in Aquaculture Systems	1+1
AQC 608	II	Aquaculture Medicine	1+1
In addition to above minor courses students can choose minor courses from below given related disciplines			
<ol style="list-style-type: none"> 1. Fish Nutrition and Feed Technology 2. Fish Genetics and Breeding 3. Fish Biotechnology 4. Fisheries Resource Management 			

Supporting Courses (The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence):

Suggestive courses:

Course Code	Semester	Course Title	Credits
FST 601	I	Advanced Statistical Methods	2+1
FST 602	II	Software for Fisheries Data Analysis and Management	0+2

Course Contents Ph.D. in Aquaculture

AQC 601 Hi-tech Aquaculture Production Systems 2+ 1

Objective:

To learn the advanced aquaculture production system research for different species globally

Theory

Unit I

Introduction: An overview of global aquaculture production, demand- consumption scenario and emerging trends, Present status, Constraints and future prospects in India and the world, Aquaculture practices in different parts of the world, Enhancing carrying capacity in culture systems.

Unit II

Biofloc technology: Principles of biofloc, Different carbon sources, Design of aeration system and biofloc reactor, Carrying capacity, C: N ratio, harvesting of biofloc, Biofloc quality and quantity, Biofloc as feed ingredient, Stocking of fish and shellfish species. Bioremediation in wastewater aquaculture.

Unit III

Minimal water exchange aquaculture systems: Principles of closed system farming, RAS, Components, design of mechanical and biological filters for the water reuse system, Sludge removal, disposal of wastes and control of pollution to the environment, Design of RAS, biofiltration and nitrifiers, Suitable cultivable species for indoor culture systems, polyhouses.

Unit IV

Aquaponics: Principles, Components and design of different aquaponics systems, Components in aquaponics, ratio of fish and plants, Water quality and system maintenance, Resource utilization, Nutrient recycling and zero discharge of nutrients.

Unit V

Running water systems: Flow-through system, Raceways (IPR), IMTA, Partitioned Aquaculture Systems (PAS), Aquamimicry systems.

Unit VI

Other farming methods: Cluster farming, Organic farming, Satellite farming, co-operative farming and conservation aquaculture, Network of production and marketing aspects, Economics of super intensive farming systems, Advantages and disadvantages.

Practical

Design, fabrication and performance evaluation of biofloc systems; Different equipment in closed grow-out system; Aerators, Biofilters, RAS, Raceways, IMTA, PAS and aquaponics systems; Plankton and microbial analysis of biofloc. Studies on different C: N ratio; Nutrient analysis in aquaponics; Visit to hatcheries with super-intensive models. Identification and understanding the network of the systems; Market analysis for the produces; Analysis of economic advantages, case studies

AQC 602

Seed Production and Hatchery management

2+ 1

Objective:

To gain knowledge in the latest research in seed production methods for finfishes and shellfishes along with hatchery management technology.

Theory

Unit I

Reproductive biology: High value cultivable fishes, Crustaceans and molluscs. Reproductive behaviour of fishes, Sex determination, Anatomy and morphology of reproductive organs, Gametology and factors influencing the gamete quality.

Unit II

Broodstock management: Factors affecting the maturation and spawning of cultivable finfishes and shellfishes, Nutritional and environmental requirement for brood stock

and their manipulation for early maturation, Criteria for the selection of brood stock, selective breeding strategies, Tagging, Transportation of broodstock, Natural and synthetic anaesthetics for transport, Vaccines and therapeutics for health management of brood stock, Brood stock quality determination and hormonal dynamics.

Unit III

Induced Spawning: Inducing agents, Factors behind the development of inducing agents, Analogues development, Comparative evaluation of commercially available inducing agents, Artificial insemination in crustaceans and molluscs; cryopreservation of gametes and embryos in finfishes and shellfishes, Artificial fertilization protocols.

Unit IV

Larval Nutrition: nutritional requirement of larvae and post larvae, live food culture, nutritional enrichment of live food organisms, different live feed products like powdered algae, algal paste, micronized algae, vitamin fortified algal products, formulation of artificial diets.

Unit V

Hatchery management: Water quality management in hatcheries; physico-chemical and biological approaches; Strategies to control diseases in hatcheries, Diagnosis, quarantine procedure, Prebiotics, Probiotics use in hatcheries, Seed quality testing methods and seed certification, Use of immunostimulants and immune modulators in hatcheries, SPF and SPR, Effluent treatment in hatcheries, Seed transportation methods.

Unit VI

Seed production and hatchery technology: Advances in seed production of commercially important finfishes and shellfishes, Artificial propagation of seaweeds (tissue culture), Recent technologies for enhancing survival and growth in nurseries, Nursery technology for different finfishes and shellfishes, Legal issues in seed quality and marketing.

Practical

Determination of brood stock quality; Quantitative and qualitative determination of fish gametes like sperm motility, viability, counts; Cryopreservation of fish and shellfish gametes; Artificial fertilization in fishes; Project preparation for constructing hatchery (freshwater fish, marine fish, shrimp, molluscs); Broodstock quarantine in hatcheries; Live feed culture; Methods to identify quality of seeds (stress test, microscopic examination); Water quality management in hatcheries; Disease identification and treatment in hatcheries; Visit to hatcheries.

AQC 603 Aquaculture Ecosystem Management and Climate Change 2+ 1

Objective:

To learn the impact of aquaculture on ecosystem management and climate change effects.

Theory

Unit I

Aquaculture and ecosystem relationship: Ecosystems and productivity, Biotic interaction within ecosystems and ecological homeostasis, Climate; Weather elements of concern in aquaculture, Greenhouse gases, Global warming and their impact.

Unit II

Impact of environment on aquaculture: Raw water source, Physical and chemical characteristics, Contaminants and pollutants (algae, pathogens, heavy metals, pesticides) and their effect on productivity.

Unit III

Impact of aquaculture on environment: Waste water discharge, Its quality and quantity, Impacts of effluents on ecosystems, Chemical degradation of soil and water.

Unit IV

Environment monitoring: Problems and preventive measures of antibiotic and drug residues, Salinization of soil and water, Eutrophication, Environment impact assessment and environmental audit.

Unit V

Sensor based monitoring: Biosensors in aquatic environment, Toxicity assessment, eco-labeling and traceability, Environment management.

Unit VI

Environment threats: Introduction of exotics and escape of farmed fish, Pathogens in aquatic environment, Safety of aquaculture products, Role of microbes in aquatic environment, Assessment of probiotic impact in aquaculture.

Practical

Waste water analysis, Toxicity assessment studies; Eco-labelling and traceability, Isolation, nutrients budgeting, Quantification and administration of solid and liquid doses, Physical and chemical characteristics of soil, Design and construction of effluent treatment plant. Carbon credit/ budgeting.

AQC 604 Fish and Shellfish Physiology and Endocrinology 2+ 1

Objective:

To gain knowledge on finfish and shellfish endocrinology and physiological aspects.

Theory

Unit I

Endocrine system: Endocrine glands in fishes, Hormones and their kinetics, Structure and function of neuro-endocrine system in finfish and shellfish, Hormonal control of physiology.

Unit II

Hormones: Chemical nature of hormones, synthesis, storage, Release and control of hormones, Homeostasis, Endocrine control of growth and metabolism in fishes, Exogenous hormone administration, Implication, Impact on the general health and wellbeing of fishes.

Unit III

Influence of hormones: Eco-physiology, Adaptive mechanisms - reversible and irreversible changes, Physiology of migration and behaviour.

Unit IV

Neurophysiology: Neurosecretory system in fishes, Crustaceans and molluscs, Neurotransmitters, Physiology of ecdysis.

Unit V

Reproductive physiology: Endocrine control of maturation, spermatogenesis, oogenesis, spawning vitellogenesis.

Unit VI

Respiratory physiology: Gas exchange concept, Excretion and osmoregulation.

Practical

Dissection of finfish and shellfish to study endocrine glands, Hormone assay – ELISA, Histological techniques to study reproductive and endocrine glands, Identification of moult stages, Application of respirometer and osmometer.

AQC 605

Feed Management in Aquaculture

1+ 1

Objective:

To learn the latest research in the lines of understanding the influence of environment on nutrient utilization

Theory

Unit I

Nutrient dynamics: Influence of nutrient cycles on web/chain, Influence of detrital food web on nutrient distribution, Nutrient loading through feed and fertilizer, Natural feed augmentation for increasing fish production, Different food chains in aquatic ecosystem, Feeding behavior and feeding niche, Effect of environmental parameters on appetite of fish.

Unit II

Eco-friendly feed: Use of exogenous phytase and acidifiers, high energy diets, methods of enhancing feed digestibility, biofloc and probiotics influences.

Unit III

Nutritional pathology: Deficiency and imbalance diseases: essential amino acids, essential n-3 and n-6 fatty acids deficiencies, Micronutrients: fat-soluble vitamins, water-soluble vitamins; Macro- elements, trace-elements and mineral toxicity, Influence of stress on feed intake, Digestion and absorption, Stress indicator and nutritional strategies for mitigate stress.

Unit IV

Feed Management: Impact of feed and nutrition on environment, Nutrients affecting the water quality, Nutritional strategies to reduce the nutrient flow in aquaculture system, Contribution of feed waste to organic load of aquaculture production systems, Role of additives in reducing environmental pollution.

Practical

Practical Study of influence of thermal stress, Hypoxia, Salinity and pH, Stress enzyme. (LDH, catalase, SOD, glutathione peroxidase), Stress hormone (Cortisol) and sex steroid hormone.

AQC 606 **Applied Biotechnology in Aquaculture** **1+ 1**

Objective:

To learn about applied biotechnology aspects in aquaculture.

Theory

Unit I

Introduction: Scope of biotechnology in fisheries and aquaculture research. Vaccination in fishes- DNA vaccines, sub Unit Vaccines and Biofilm Vaccines.

Unit II

Feed biotechnology: Probiotics, single cell proteins, Nutraceuticals, Gnotobiotics. Recombinant proteins of commercial importance: enzymes, hormones, bioactive compounds, therapeutic proteins. Anti- microbial Peptides and their applications.

Unit III

Environmental Biotechnology: Bioremediation, biosensors, biofouling, treatment of waste water, Applications of biotechnological tools: Transgenic technology, Recombinant DNA, Monoclonal antibodies, Cell lines and stem cell culture, DNA markers and MAS, Biotechnological instrumentation in Aquaculture.

Unit IV

Constraints and Limitations: Biochemical and Molecular Markers; Commercial applications of Fish Biotechnology; Government regulation of Transgenic fish and Biotechnology products.

Practical

Cell culture and cell lines; Development of hybridoma and production of monoclonal antibodies; Preparation of chromosomes from embryos and young fish Ploidy determination by RBC measurement and chromosome numbers; DNA markers; Gene transfer experiments; Northern blotting and southern blotting for integration and expression of transgenes.

AQC 607 **Automation in Aquaculture Systems** **1+ 1**

Objective:

To understand the possible automation in aquaculture systems for efficient management and enhanced income

Theory:

Unit I

Introduction: Automation principles and procedures, Economic benefits of automation, Comparison of automation in agriculture and allied enterprises, History of automation in aquaculture, Scope for automation and need for automation in aquaculture, Evolution of machines and mechanisation in aquaculture, Advantages and disadvantages of automation, Current status and prospects of automation in World and India.

Unit II

Artificial Intelligence: Definition and application of AI in aquaculture, operating systems, system architecture, modules, AI software and its characteristics; AI in aquaculture, advantages of AI

Unit III

Robotics in aquaculture: Scope for Robotics in aquaculture, ROV, AUV, Drones, ASV, Automation for water quality management and health management in aquaculture, Novel automated systems in the world, technologies in aquaculture.

Unit IV

Software's used in Automation: Use of data acquisition systems in aquaculture. Biological models related to automatic control in aquaculture; Artificial intelligence software focuses on niche markets, A plug-and-play machine vision application for aquaculture.

Practical

Automated systems description and application; Preparation of automation plans for individual systems; Robotics systems and application modules preparation; Drones and their utilization; Energy monitoring systems design and use; Trial automation in any one system.

AQC 608

Aquaculture Medicine

1+ 1

Objective:

To understand the pharmacokinetics of aquaculture drugs and chemicals

Theory

Unit I

Anaesthetics: Anaesthetics and methods of anaesthetizing fish and shellfish.

Unit II

Amendments in Aquaculture: Different chemicals and drugs used in aquaculture and dosages, Use of probiotics and immunostimulants in aquaculture

Unit III

Drug Mechanism: Action of different drugs in finfish and shellfish. Bioaccumulation and toxicity

Unit IV

Antibiotics: Antibiotics – use and misuse including development of antibiotic resistant bacteria and their impact on environment and human health

Practical

Antibiotic sensitivity test, Estimation of dose, Estimation of antibiotic residues, Detection of gut colonization by probiotic bacteria

a) Ph.D. Programme:

2) Discipline: Fish Nutrition and Feed Technology

Major Courses (12 credits):

Course Code	Semester	Course Title	Credits
FNT 601*	I	Feed Technology and Feed Mill Management	2+1
FNT 602*	I	Nutrigenomics	1+1
FNT 603*	II	Larval and Broodstock Nutrition	2+1
FNT 604*	II	Introduction to Biomolecules	2+1
FNT 607*	II	Nutraceuticals as Functional Foods	1+1
			8+5=13

***Compulsory Courses**

Minor courses (8 Credits):

(Suggestive courses from the subjects closely related to a student's major subject)

FNT 605	I	Macro and Micronutrient Nutrition	2+1
FNT 606	I	Bioenergetics	2+1
FNT 608	II	Feed intake and feeding behaviour	1+2
FNT 609	II	Feed and environment	2+1
		Total	7+5 =12

Courses relevant for student's research work or necessary for building his/her overall competence from following disciplines can also be taken as minor courses.

1. Aquaculture, 2. Fish Biotechnology, 3. Aquatic Environment management and 4. Fisheries Resource Management

Supporting Courses (5 credits): The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence can be taken. A few courses are suggested as under:

Course Code	Semester	Course Title	Credits
FST 601	I	Advanced Statistical Methods	2+1
FST 602	II	Software for Fisheries Data Analysis and Management	0+2

Doctoral Seminar (2 credits):

Course Code	Semester	Course Title	Credits
FNT 691	III	Doctoral Seminar	0+1
FNT 691	IV	Doctoral Seminar	0+1

Doctoral Research (75 credits):

Course Code	Semester	Course Title	Credits
FNT 699	II to VI	Doctoral Research	0+75

FNT 601 FEED TECHNOLOGY AND FEED MILL MANAGEMENT 2+1

Objective:

To study the feed formulation techniques; design of feed mill and feed manufacturing; feed quality assurance and regulations.

Theory**UNIT I**

National and global scenario of feed ingredients and feed industry: Availability demand and supply; Types of feeds, BIS and international standards for fish feed, Overview of feed mill business.

UNIT II

Feed formulation: Different methods of feed formulation, Use of feed formulation softwares; Nutritional and physical quality of feed ingredients; Importance of additives formulation of nutritionally balanced diet (amino acid, micronutrients)

UNIT III

Feed manufacturing process and control: Receiving of raw material, Grinding, Mixing, Conditioning, Pelleting /extrusion, Drying and cooling, Coating/top dressing, Packaging and labelling, Factors affecting feed manufacture and stability of nutrients, Effects of processing on the nutritional value of feeds, Processing methods for non-compacting feed; Economics of feed manufacturing.

UNIT IV

Emerging new feed ingredients: Scope and exploration of new feed ingredients, Anti-nutritional factors and methods of detoxification (e-beam irradiation, solvent extractions, SSF, protein concentrates/isolates, genetic improvement of plants etc.).

UNIT V

Storage and quality control: Ingredient quality assurance, Feed processing quality assurance and Processed feed quality assurance Miscellaneous adventitious toxins and Effect on feed safety; Storage of feed and quality deterioration, CGMPs and HACCP feed regulation, Feed transmitted bioterrorism and its implications.

UNIT VI

Design of a feed mill unit: Layout, Feed mill design and safety of operation, Maintenance and record keeping.

Practical

Analysis of anti-nutritional and toxic substances in feed ingredients and feed; Formulation of diets using software, Preparation of different types of feed and their quality evaluation; Effect of feed storage on nutritional value of feed, Preparation of farm made feeds.

Objective:

To understand the role of nutrients on gene expression

Theory**UNIT I**

Principles of nutrigenomics: Methodologies, Genomics, Transcriptomics, Proteomics, Metabolomics and Nutrigenomics, Gene structure and Regulation, Nutritionally Important genes, Nutrient-gene interaction and expression.

UNIT II

m-RNA and cDNA: Extraction of m-RNA, reverse transcription and cDNA biosynthesis, Cloning techniques; Genomic and differential gene expression.

UNIT III

Use of DNA probe: Blotting and hybridization, Microarray; Microarray nitrocellulose hybridization and labelling with P³² probes; Quantitative real time polymerase chain reaction (qRT PCR).

UNIT IV

Bioinformatics: Gene expression software; BLASTIN, FASTA and PHYLIP etc.; Relative expression software tool (REST); Interpretation of microarray data; Cloning technique.

Practical

Genomic DNA, plasmid DNA and RNA extraction and isolation, m-RNA purification; cDNA synthesis by reverse transcription from fish tissue; Elution of PCR product for gene sequencing; RT PCR, cloning, exploration of bioinformatics tools.

FNT 603 LARVAL AND BROODSTOCK NUTRITION 2+1**Objective:**

To understand the role of nutrition in reproductive performance and larval development of fish and shellfish

Theory**UNIT I**

Embryonic and larval development: Nutritional profile of egg yolk and mechanism of egg yolk utilization, Degradation of egg yolk platelets and granules, Utilization of egg protein, Amino acid and lipid, Influence of abiotic factors on yolk absorption; Criteria for evaluation of early larval development

UNIT II

Larval digestive system: Ontogenesis of digestive systems, Digestion and absorption of protein and lipid, Mechanism of transition from endogenous to exogenous nutrition.

UNIT III

Larval nutrition: Importance of live foods, Weaning diets and their importance in larval nutrition, Nutritional requirements and deficiency symptom, Nutritional status of larvae.

UNIT IV

Broodstock nutrition: Effect of nutrition on fecundity, Fertilization, Embryonic development and larval quality.

UNIT V

Improving brood-stock performance: Special ingredients and specific nutrients for improving gonadal development and reproductive performance; Effective feeding periods for optimum brood-stock performance.

UNIT VI

Feeding strategies: Manual, Mechanical and automatic feeding; Feeding devices and strategies, Larval feeding behaviour and feed management.

Practical

Preparation of larval feed, Nutritional profiling of egg yolk and larvae, Nutritional analysis of live food organisms, Estimation of proteases in larvae, Estimation of gonado-somatic index and fecundity.

FNT 604

INTRODUCTION TO BIOMOLECULES

2+1

Objective:

To study the importance of different biomolecules and their biological functions in a biosystem.

Theory

UNIT I

Definition, types, structure, properties of biomolecules: Protein, Lipids, Carbohydrates, Vitamins, Minerals, Nucleic acids and Water as biomolecules and its applications, Water: importance of water in biological systems with special reference to the maintenance of native structure of biological molecules, Water as a universal solvent, pH, buffers, buffer capacity and their importance in biological systems.

UNIT II

Protein and amino acids: Protein and its classification, Structure of proteins, Primary, Secondary (helix and pleated sheet), Tertiary and Quaternary structures of protein and forces stabilizing it, Denaturation and renaturation of proteins, Ramachandran's plot, Amino acids and its structural features, Stereoisomerism, R and S notations, Structure and classification of standard amino acids, pH titration curve, Isoelectric pH of amino acids and pKa value, Peptides and structure of peptide bond.

UNIT III

Lipids: Classification and their biological role, Fatty acids: nomenclature, structure and properties of saturated, Unsaturated, Essential fatty acids, Triacylglycerols; Nomenclature, Physical properties, Chemical properties (hydrolysis, esterification,

Rancidity of fats, saponification value, iodine value, Acid value) and significance, Chemistry and biological function of eicosanoids, fats, waxes and phospholipids and cholesterol.

UNIT IV

Carbohydrates: Classification and biological importance of carbohydrates, Structure of monosaccharides, stereochemistry, D and L, Epimers, Anomers, Diastereomers and Mutarotation, Disaccharide, Establishment of glycosidic linkage in sucrose, Maltose, lactose, Deoxy ribose and ribose sugar, Polysaccharides: Types, partial structure, Occurrence and importance of starch, Glycogen, Insulin, Cellulose, Chitin, Pectin, Reactions of carbohydrates Molisch's, Benedicts / Fehlings, picric acid, Barford's, Bials, Seliwanoff's, Osazone test.

UNIT V

Vitamins and minerals: Water soluble vitamins – B complex and Vitamin C: Structural formula, Co-enzyme forms, Biological role, Deficiency symptoms and dietary sources, Vitamin C as a redox reagent, Fat soluble vitamins, A, D, E, andK: structure, Dietary sources, Requirements, Deficiency symptoms and Biological role, Mineral macronutrients and micronutrients, Dietary sources, Physiological functions, Deficiency disorders, Absorption and excretion, Importance of selenium and fluorine, Metals in biological system: Fe, Co, Ca, Mb, Cu.

UNIT VI

Nucleic acids and water: Nucleic acids, Nucleosides and Nucleotides; Structure and properties, Phosphodiester bonds, Chemical differences between DNA and RNA and its significance, Different class of RNAs - mRNA, rRNA, tRNA and snRNA. Primary, secondary and tertiary structure of tRNA, Determination of primary structure (sequencing) of DNA using Maxam-Gilbert method and Sangers method and limitations.

Practical

Preparation of buffers, Qualitative estimation of carbohydrates, Quantitative estimation of glucose and maltose by DNS method and any other methods, Quantitative estimation of protein by Biuret and Folin Lowry's method, Estimation of lipid by Zak's method, Estimation of vitamin C.

FNT 605 MACRO AND MICRONUTRIENT NUTRITION 2+1

Objective:

To understand recent developments in macro- and micro-nutrient nutrition for fish and shellfish

Theory

UNIT I

Protein and amino acids: Requirements, Functional roles of amino acids, Ideal protein concept, Nitrogen excretion, Amino acid antagonism, Improving nitrogen Retention, dietary supply of synthetic amino acids in different forms.

UNIT II

Lipid and essential fatty acids: Functions and deficiencies, Fatty acid oxidation, antioxidants, Role of phospholipids and steroids.

UNIT III

Optimization of carbohydrates in diets: Strategies for improving carbohydrate utilization; Potential of exogenous enzymes, solid state fermentation (SSF).

UNIT IV

Micronutrients: Physiological roles and functions of vitamins and minerals; Forms of supply of minerals and vitamins, Deficiency symptoms.

UNIT V

Recent developments in energy nutrition and feed additives: Recent advances in nutritional energetics and feed additives, Medicated feeds (farm-made and commercial), Regulations and certification of feed additives.

UNIT VI

Designer fish production: Tailoring flesh quality, food safety, Roles of nutrients and additives (fatty acids, antioxidants, drugs etc.), Flesh quality evaluation (colour, texture and sensory), Estimation of fatty acids, Amino acids and minerals in ingredients, feeds and flesh of fish and shrimp; Dietary effects on nitrogen excretion.

Practical

Protein quality estimation (PER, NPU). Digestibility studies. Estimation of fatty acids and amino acids.

FNT 606

BIOENERGETICS

2+1

Objective:

To understand the principles of energetics, nutrient energy and its metabolic scope in larval, growout and broodstock fish

Theory

UNIT I

Energy requirements of fish: Principles and methods; Factors affecting energy requirement; Energy budgeting, Metabolic rate and Factors affecting it.

UNIT II

Metabolic scope: Its variation in herbivores, Omnivores and Carnivores.

UNIT III

Larval energetics: Growth, metabolism and energy budget, Energy relationship between egg and hatchlings, Energy flow during early ontogenesis.

UNIT IV

Energetics of growout and brood stock: Energetics of feeding and digestion, Energy requirements for growth and reproduction, Energetics of gonadal maturation and

gamete production, Bioenergetics of spawning, Relationship between feeding and maturation.

UNIT V

Lipids: Lipids as energy source, Net energy supply from lipids, Fatty acid biosynthesis and degradation, Transport and deposition of lipids in finfish and shellfish, Fatty acid bioconversion (elongation and desaturation) in different species, Importance of phospholipids and cholesterol.

UNIT VI

Carbohydrates: Carbohydrates as energy source; Net energy supply from carbohydrates; Biosynthesis, Storage and Degradation, Interaction of carbohydrate with lipid and protein.

Practical

Estimation of oxygen consumption; Estimation of energy flow, Estimation of gross energy and digestible energy of feed; Study of energy requirements of, herbivorous, omnivorous and carnivorous fish; Estimation of total and free cholesterol; Estimation of metabolic rates.

FNT 607	NUTRACEUTICALS AS FUNCTIONAL FOODS	1+1
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Objective:

To understand the role of nutraceuticals in the physiological wellbeing of fish and shellfish.

Theory

UNIT I

Functional foods v/s Nutraceuticals: Definitions, concepts and beneficial roles, Application of functional foods in immune modulation and disease prevention.

UNIT II

Characteristics of nutraceuticals and delivery systems: Nanotechnology of drug delivery system such as biocompatible polymers, Stimuli responsive polymers

UNIT III

Modes of action and benefits: Probiotics, Prebiotics, Stanols and Sterols, Their immunomodulatory effects.

UNIT IV

Stress mitigation and growth enhancement: Inter-relationships of stress and growth in fish, Functional feed additives and role of functional foods in stress mitigation and growth enhancement.

Practical

Estimation of immunomodulatory parameters (lysozyme, NBT, MPO, antibody titre), Estimation of antioxidant enzymes (SOD, catalase, GPx), Extraction of bioactive compounds, in vitro antioxidant assay, Pro PO.

Objective:

To study the mechanism of feed intake and feeding behaviour.

Theory**UNIT I**

Gustation and feeding behaviour: Chemoreception, olfactory, Peripheral gustation sensation, Gustatory pathways in the Central Nervous System, Taste and feeding behavior.

UNIT II

Feed intake: Techniques for the measurement of voluntary feed intake, Stomach content analysis, Chemical markers, Direct observation and video recording, Demand feeder, X-radiography, factors affecting voluntary feed intake, Effect of feeding time on feed intake and growth.

UNIT III

Regulation of feed intake: Neuropeptides and hormones, Inhibitory peptides, Stimulatory peptides, Growth hormones, Nutrient receptors and transporters, Hormonal control of metabolism; Nutrients influencing feed intake gustatory feeding stimulants.

UNIT IV

Physiological effects of feeding: Methods of feeding and short-term effects of meal on post-prandial levels of nutrients; Tissue metabolic physiology; Feeding frequencies, Physiology of starvation and feed restriction.

Practical

Measurement of feed intake by chemical marker, Feed intake measurement with respect to temperature, Experiment on feeding stimulant, Feed intake and blood glucose correlation, Comparative intake of natural vs artificial feed, Monitoring feeding behaviour in different species, Evaluation of fish response to feed in terms of feed detection and intake, Study of crustacean feeding behavior in different life stages, Study of digestive anatomy and morphology and their correlation with digestive physiology, Impact of feeding regimes on feed intake.

Objective:

To understand the impact of nutrient utilization on environment

Theory**UNIT I**

Nutrient dynamics: Influence of nutrient cycles on food web/chain. Influence of detrital food web on nutrient distribution, Nutrient loading through feed and fertilizer.

UNIT II

Stress and nutrition: Influence of stress on feed intake, Digestion and absorption, Stress indicator and nutritional strategies to mitigate stress.

UNIT III

Eco-friendly feed: Use of high energy diets, optimizing protein energy ratio, ideal amino acid profile, improving nutrient utilization through exogenous phytase and acidifiers, Methods of enhancing feed digestibility, Biofloc and probiotics influences on nutrient utilization.

UNIT IV

Impact of feed on environment: Judicious use of feed and nutrients; Nutrient build up on water quality; Nutrient management in different aquaculture systems (extensive, semi-intensive, intensive- recirculatory systems); Nutritional strategies to reduce the nutrient flow in aquaculture system, Contribution of feed waste to organic load of aquaculture production systems, Reducing environmental pollution (use of additives, weeds etc.).

UNIT V

Productivity and fish production: Optimization of natural productivity for increasing fish production, Different food chains in aquatic ecosystem, feeding behavior and feeding niche, Effect of environmental parameters on appetite of fish

UNIT VI

Environmental impact assessment: Rules and Regulations on waste management in aquaculture (International and National)

Practical

Assessment of water quality parameters (ammonia, nitrite, nitrate, chloride phosphate etc.) as affected by feeds; Levels of feeding and water quality; Stress enzymes (catalase, SOD, glutathione peroxidase), stress hormone (cortisol).

b. Masters Programmes

1) Discipline: Aquaculture

Major courses

Course Code	Semester	Course Title	Credits 20
AQC 501	I	Freshwater Aquaculture Production Systems	2+1
AQC 502	II	Coastal Aquaculture and Mariculture Farming Systems	2+1
AQC 503	II	Hatchery Technology for Finfishes and Shellfishes	2+1
AQC 504	I	Aquaculture Policy and Planning	1+1
AQC 505	I	Fish Nutrition and Feed Technology	2+1
AQC 506	II	Soil and Water Quality Management in Aquaculture	2+1
AQC 507	I	Therapeutics and Health Management in Aquaculture	2+1
AQC 591	IV	Master's Seminar	0+1

		Total	13+8=21
AQC 599	III and IV	Master's Research	0+30

Minor courses

(These are the suggestive courses from the subjects closely related to a student's major subject)

Course Code	Semester	Course Title	Credits
AQC 508	I	Larval Nutrition and Live Feed Production	1+1
AQC 509	I	Aquaculture Engineering	1+1
AQC 510	II	Open Water aquaculture	1+1
AQC 511	II	Commercial Ornamental Fish Breeding and Culture	1+1
AQC 512	I	Computer Application in Aquaculture Data Processing	0+1
AQC 513	I	Inland Saline Aquaculture	1+1
AQC 514	II	Multilevel Integrated Aquaculture Systems	1+1
AQC 515	II	Coldwater Aquaculture and Recreational Fisheries	1+1
AQC 516	I	Recirculating Aquaculture Systems	1+1
In addition to above minor courses students can choose minor courses from below given related disciplines			
1. Fish Genetics and Breeding			
2. Fish Biotechnology			
2. Fisheries Resource Management			

Common Courses: (Non Credit)

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Information Services	0+1
PGS 502	I	Technical Writing and Communication Skills	0+1
PGS 503	II	Intellectual Property and its Management in Agriculture	1+0
PGS 504	I	Basic Concepts in Laboratory Techniques	0+1
PGS 505	II	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
		Some of these courses are already in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platforms. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HoD/BoS.	

Supporting Courses (The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence):

Suggestive courses:

Course Code	Semester	Course Title	Credits
STAT 501	I	Mathematics for Applied Sciences	2+0
STAT 502	I	Statistical Methods for Applied Sciences	3+1
STAT 511	II	Experimental Designs	2+1
STAT 512	II	Basic Sampling Techniques	2+1
STAT 521	I	Applied Regression Analysis	2+1
STAT 522	II	Data Analysis Using Statistical Packages	2+1
MCA 501	I	Computers Fundamentals and Programming	2+1
MCA 502	II	Computer Organization and Architecture	2+0
MCA 511	I	Introduction to Communication Technologies, Computer Networking and Internet	1+1
MCA 512	II	Information Technology in Agriculture	1+1
BIOCHEM 501	I	Basic Biochemistry	3+1
BIOCHEM 505	II	Techniques in Biochemistry	2+2

Course Contents and Syllabus of M.F.Sc. (Aquaculture)

AQC 501 2 + 1	Freshwater Aquaculture Production Systems
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Objective:

To gain knowledge and understand the recent advances in freshwater fish and prawn farming under different culture systems.

Theory

Unit I

Introduction: Present status, hindrances / problems / constraints and prospects for fish and prawn farming in global and Indian perspective. Development process, different supports and driving factors for production enhancement.

Unit II

Aquaculture systems: Extensive, semi-intensive and intensive culture of fish and prawn. Partitioned aquaculture systems: raceways, tanks, flow-through systems, polyculture, and composite fish culture. Cages and enclosure. Peri-urban aquaculture systems: aquaponics, RAS, flow- through systems, bio-floc technology and landbased aquaculture systems.

Unit III

Aquaculture practices for cultivable species: Carps, Catfish, Snakeheads, Featherbacks, Tilapia, Mahseer, Trouts and freshwater Prawn. Grow out practices: pre stocking, post stocking management, harvesting and BMP. Other alternative species for high production. Species selection and crop planning. Economics of different fish farming systems

Unit IV

Freshwater prawn farming: Monoculture practice of prawn in ponds, all-male culture and its advantages, polyculture with carps, prawn farming in inland saline soils. Nursery rearing, sex segregation, pond preparation, stocking, feeding and water quality management, disease prevention and treatment; Harvesting methods, handling and BMP.

Unit V

Integrated farming systems: Design, farming practices, constraints and economics of IFS of fish with vegetables, fodder, paddy, cattle, pig, poultry, duck, rabbit and quail. IMTA, Freshwater pearl culture, multi- level integrated system. Resource utilization and conversion of waste to wealth.

Unit VI

Wastewater-fed aquaculture: Water treatment methods, species selection, culture practices, harvesting and depuration process. Merits and demerits of wastewater fed aquaculture systems. Pre-requisites and precautions to be taken in the technology adoption.

Practical

Identification of commercially important cultivable finfish and shellfish species; Assessment of seed quality- stress test; pre-stocking factors evaluation and observation; Calculating carrying capacity of pond and stocking density; Check tray assessment and feed ration calculation; Sampling process and species wise growth estimation; Farm feed production and feeding; Lime and fertilizer requirement calculations; Farm visits and observation; Records keeping and data analysis; Modelling of different culture systems.

AQC 502 Coastal Aquaculture and Mariculture Farming Systems 2 + 1

Objective:

To gain knowledge in establishing and managing different fish/shellfish farming systems in coastal zone and marine waters.

Theory

Unit I

Introduction: Overview of coastal aquaculture and open sea mariculture; Present trend and future prospects in India. Practices in tropical countries, production levels and adoption of technology. Major bottlenecks in the practices

Unit II

Different farming systems: Cage and pen culture – types, site selection, construction, specifications for different species; Raft and rack culture – Principles, site selection, design and construction; operations and troubles shooting, threats and environmental issues; Land based aquaculture. Principle, design, construction and operations, rules and legislations

Unit III

Aquaculture of finfishes: Distribution, biology, seed collection, nursery rearing, weaning on artificial feed, culture techniques, feeding strategies, constraints and scope (Seabass, milkfish, pearlspot, seabreams, grouper, snapper, cobia, pompano).

Unit IV

Shrimp farming (*Penaeus monodon*, *P. indicus*, *P. semisulcatus*, and *Litopenaeus vannamei*): Systems of farming – extensive, semi- intensive, intensive and super intensive (Biofloc, RAS, etc.); site selection, design and construction of culture systems, pond preparation, stocking, feed and water quality management, disease prevention and treatment; use of probiotics and prebiotics: harvesting and handling; continuous stocking and harvesting, staggered harvest, management of differential growth; shrimp farming in undrainable ponds. Mud crab fattening, production of soft-shell crabs and Lobster culture.

Unit V

Culture practices for marine molluscs and echinoderms: Present status and future prospects in India, Species cultured (mussels, oysters, pearl oysters, clams, abalone, sea cucumber) distribution, biology, practices followed in India and other Asian countries, farming methods–different types and culture methods; Problems and prospects.

Unit VI

Seaweed farming: Major seaweed species of commercial importance; tissue culture of seaweeds, methods of culture; farming of agar, algin and carragenan yielding species; emerging trends in their farming in open seas; Integration with other coastal and marine farming systems.

Practical

Identification of commercially important cultivable finfish and shellfish species; Assessment of seed quality, rearing techniques; Feeds for nursery rearing, preparation and evaluation; pre-stocking factors in different systems, valuation and observation; Calculating carrying capacity of pond and stocking density; Cage construction, pen construction and identification of bottlenecks; Sampling process and species wise growth estimation; Construction of rafts and mollusc culture; Seaweed collection and identification; Farm feed production and feeding; Disease identification and management; Visits to cage sites and observation; Records keeping and data analysis; Modelling of different culture systems.

AQC 503 Hatchery Technology for Finfishes and Shellfishes 2 + 1

Objective:

To learn research outlines and recent advances in seed production and hatchery management of commercially important cultivable finfishes and shellfishes.

Theory

Unit I

Introduction: Current status; problems and prospects of seed of different shellfish & finfish species – freshwater and marine. Site selection and techniques of collection; identification and segregation of finfish and shellfish seed, handling, packing and transportation. Natural collection processes and their merits and demerits.

Unit II

Reproductive biology: Morphology and reproductive physiology; gonad anatomy; histology of gonad; Hormonal pathways and mode of control; Spermatogenesis and oogenesis; gametology (evaluation of milt and egg); Overview of current developments in reproductive biology of commercially important finfishes and shellfishes.

Unit III

Environmental and nutritional control of reproduction: Reproductive cycles, factors influencing reproduction (Photoperiod, change in water quality and quantity, temperature, lunar cycle, etc.), simulated environment and exogenous hormonal stimuli. Nutritional factors (types of feed - live and prepared feeds, nutritional quality, quantity, feeding management, feed utilisation, etc.) affecting maturation, spawning and nursery rearing.

Unit IV

Induced spawning: Brooder development, quality and its health management, transportation of brooders, hormonal and environmental stimulation, use of different natural, synthetic hormones and analogues and their application; GnRH and LINPE models, PIT tagging, Canulation and volitional spawning, Estimation of spawning efficiency, cryopreservation of gametes.

Unit V

Hatchery management: Indian major and minor carps, exotic carps, catfishes, tilapia, mahseer, murrels, Trout, Seabass, milkfish, mullets, grouper, snapper, breams, pompano, and cobia. Seed production of commercially important prawns (*Macrobrachium rosenbergii*), shrimps (*Penaeus monodon*, *P. indicus*, *P. semisulcatus*, and *Litopenaeus vannamei*), crabs (*Scylla serrata*, *Portunus pelagicus*), spiny lobsters (*Panulirus spp*), mussels, edible oysters, pearl oyster and clams.

Unit VI

Seed quality: Hatchery protocols, water quality management, larval rearing, estimations, trouble shooting in hatcheries, record keeping, packing and transport of seed, anaesthetics in fish seed transport. Quarantine and Hatchery protocols and biosecurity principles; sanitary and phytosanitary (SPS) measures; Better Management Practices (BMPs); packaging and transport of seed. SPF brood stock development. Economics of seed production of different species

Practical

Study of primary and secondary sexual characters; Brooder handling and morphological features recording; Gonadal development observation in finfish and shellfishes; Histological observation of gonads and eggs; Estimation of GSI, Fecundity, Absolute fecundity, Egg parameters, Ovarian features; Collection and identification of cultivable finfish seed; Seed quality character identification;

Observation and analysis of inducing agents; Induced breeding of fishes through various inducing agents; Evaluation of carp milt and egg; Cryopreservation of gametes; Preparation of brood and larval feed for different cultivable finfish and shellfish; Packing and transportation of cultivable finfish and shellfish seed; Visit to different finfish and shellfish hatcheries.

AQC 504	Aquaculture Policy and Planning	1 +
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Objective:

To gain in depth knowledge to develop aquaculture policies for the sustainable aquaculture practices

Theory

Unit I

Sustainability issues: Environmental and Socio-economic issues; Exotic species introduction; escapement; contamination of indigenous gene pool; salinization of soil and water; environmental impact; over exploitation of wild stocks; mangrove deforestation. EIA, eco-system approach to aquaculture. Conflicts over water and land use; conflicts of interest between aqua farmers and fishermen, aquaculture and other enterprises; social issues; anti-dumping duties.

Unit II

Climate Change Impact: Weather elements of concern in aquaculture, Green house gases, global warming and their impact, Carbon sequestration in aquaculture, Microplastics in Aquaculture measures and tools to reduce energy use and greenhouse gas emission in aquaculture.

Unit III

Strategies for sustainability: Sustainability concept; food security; biosecurity; organic farming; responsible aquaculture; rotational aquaculture; bioremediation; role of biotechnology, traceability. Energy conservation. Application of renewable energy in aquaculture- solar energy, wind, and tidal energy, Seed certification, Sustainable use of antibiotics, minimal water exchange system, natural productivity, preservation of natural resources.

Unit IV

Guiding principles for sustainable aquaculture: Coastal Aquaculture Guidelines Source Book, FAO Code of Conduct for Responsible Fisheries; Holmenskollen Guidelines for Sustainable Aquaculture. BMP, CRZ implications, CAA and it's role, ecolabelling, organic certification. PCB and State water bodies protection guidelines.

Practical

Visit to conventional aquafarm to see the management of used water; Survey on environmental impact on nearby aquaculture farms; Applications of remote sensing and GIS (geographical information system); Economic evaluation of aquaculture practices. Case studies on environmental issues of different types of farms.

Objective:

To learn the nutritional requirements and feed equipment's of major cultivable to develop new and novel feeds for the commercial aquaculture

Theory**Unit I**

Introduction: Need for studying the nutritional requirements of cultivable fishes, feed formulation, Methods to study the nutritional requirements, and its need.

Unit II

Feed ingredients and Feed preparation: Commonly used feed ingredients in aqua feeds, Novel feed ingredients, estimation qualities of feed ingredients, Qualities of feed ingredients that determine feed quality, Selection of ingredients, Formulation of feeds, Feed processing and making. Different feed preparation methods.

Unit III

Types of feeds: Floating, semi-floating, sinking and stable feeds for aquaculture, Feed making methods for different feeds, Nutrient leeching in feeds, feed quality determination and feed making, Evaluation of feeds, Simulated system evaluation, lab analysis.

Unit IV

Advanced feeds: High energy feeds, Alternative protein sources for feeds, maturation diets to enhance breeding efficiency, Larval feeds, bio availability in feeds, High FCE and economic benefits of feeding in the farming, Live feed enrichment, Bio-routing of nutrients, Chemo-therapeutants, Other growth promoting agents through live feeds. Evaluation of bio-accumulation and bio-utilisation.

Unit V

Feed processing technology: Common processes in feed manufacture; Grinding, Dosing, Homogenization; Extrusion cooking; Complimentary processes; Drying, crumbling, coating; Use of binders; Feed manufacture productions with high energy diets vacuum coating with lipid. Equipments used in feed manufacture; Pulverizer, grinder, mixer, pelletizer, crumbler, drier, Extruder/Expander, Vacuum coater, fat sprayer

Unit VI

Quality control in fish feed manufacturing: Quality control procedures, raw materials, finished products; Geometrical, and physical feature; Mechanical characteristics in air, Behavioural characteristics in water, Feed economics and evaluation criteria: FCR, AFCR, SGR, PRE, ERE, PER, NPU.

Practical

Nutritional requirements determination for different species; Collection and analysis of different feed ingredients; Feed formulation with different feed ingredients; Feed quality analysis; Evaluation process in farms and labs; Visit to feed mills and feed making process; Economic analysis of feeding and non feeding systems; Identification of different feed additives; Observation of novel feeds and their utilization

AQC 506 Soil and Water Quality Management In Aquaculture**2 + 1****Objective:**

To learn effective soil and water quality management practices for aquaculture

Theory**Unit I**

Soil and water interaction: Physical and chemical properties of soil and water, Productivity vs. nutrient quality and quantity of soil and water; Aquatic microorganisms and their role in carbon, Nitrogen, Phosphorus and sulphur cycles and impact on aquatic habitats and species.

Unit II

Soil and water quality monitoring: Soil and water quality standards; Equipment used for soil and water quality estimations, Automated systems for monitoring, Quality checks and management, aeration system for water quality management.

Unit III

Fertilizers and manures: Different kinds of fertilizers and manures, Fertilizer grade, source, rate and frequency of application, Biofertilizers, Use of treated sewage for pond fertilization, Ecological changes taking place after fertilizing, primary production, degradation of molecules in aquatic environment, Utilization of bioactive compounds by microorganisms.

Unit IV

Soil and water conditioners: Biological indicators, Chemical and physical method of conditioning, Prebiotics, Probiotics, Minerals, Micro-nutrients and additives.

Unit V

Development of suitable soil and water quality: Cat clay/pyrite soil, Seepage, water treatment, Water filtration devices, Aeration, Chlorination, Ozonation and UV radiation, Algal bloom control, Eutrophication, Aquatic weed management, Water quality management in hatcheries.

Unit VI

Waste water treatment practices: Waste discharge standards, Role of microorganisms in fish production, Fish health and fish safety; Microbial load and algal blooms.

Practical

Preparation of water quality charts and maintenance; Equipment used in soil and water analysis; Soil sampling, determination of soil moisture and bulk density; pond filling, Analyses of mud acidity and soil texture; Measurements of temperature, pH, conductivity, salinity, transparency, turbidity and solids; Analyses of dissolved oxygen, alkalinity and hardness, phosphorus, nitrogen; Estimation of primary productivity and chlorophyll; Application of fertilizers and pond liming; Analysis of toxic elements, microbial techniques, Visit to effluent treatment plant.

AQC 507 Therapeutics and Health Management in Aquaculture**2 + 1****Objective:**

To gain knowledge on health management in aquaculture systems through diagnosis, treatment and preventing the disease outbreaks to protect aquaculture production.

Theory

Unit I

Diseases of fishes: Bacterial, Fungal, Viral diseases of fishes in farm ponds, Natural waters, and incidental outbreaks, Nutritional disorders and environmental diseases, situations for disease outbreaks, Natural immunity and disease control.

Unit II

Control of diseases in aquaculture systems: Control measures for fish diseases, Environmental and nutritional support methods for disease management, Immune modulation, Immunostimulation, Use of vaccines and other preventive methods, Control of diseases in various aquaculture systems, their limitations and benefits.

Unit III

Therapeutics: Concept of therapeutics in aquaculture, effectiveness of medication, Drugs in aquaculture, Herbal therapeutants, Use of and disuse chemicals in aquaculture, Legislation and jurisprudence in therapeutics for aquaculture organisms, Shrimp farming and control mechanism, Drug therapies for ornamental fishes, Biotraceability of antibiotics use in aquaculture.

Unit IV

Health management plans for hatcheries: Special features of hatcheries and health management of brooders, larvae, fry and young ones, Disease impacts on hatchery production, Disinfection protocol, Live feed crash due to diseases, Communicable diseases and their mechanism of spreading, Controlling outbreak of viral infections in all types of hatcheries, Economic benefits of investment in disease management.

Unit V

Modern treatment methods for fishes: Treatment methods currently in practice, isolation, Hospital tanks, Disinfection, Oral drug administration, immersion, Brooder treatment for immunity enhancement, mass treatment protocol, vaccination, advantages and disadvantages.

Unit VI

Other health management aspects: Health improvement through feeds, Medicated feeds, Chemicals for treatment of external and internal diseases, Parasite treatment, health improvement after treatment, SPF, SPR and SPT seeds, their production protocols.

Practical

Identification of disease conditions: Pathological features observation in cultivable fishes; Collection of diseased specimens and identification; Developing treatment protocols for fishes; Analysis of environmental situation favouring disease outbreaks; Epidemic conditions in farms identification; Preparation of medicated feeds, validation and observation; Hospital tanks and management; Probiotics and prebiotics identification of their effects; Visit to

hatcheries and farms to collect the specimens; Economics of different treatment methods.

AQC 508

Larval Nutrition and Live Feed Production

1 + 1

Objective:

To learn the nutritional requirements of fish/shellfish larvae and techniques on mass culture and bio-enrichment of live food organisms.

Theory

Unit I

Larval nutrition: Nutritional requirements of finfish and shellfish larvae, Nutritional quality of commonly used live feed, Comparison of live feeds against the prepared feeds, Nutritional disorders in larvae, Larval feeds utilization and advantages.

Unit II

Formulation and preparation of artificial feeds: For larval rearing, Micro particulate diets, Particulate and microencapsulated diets, High energy feeds, energy sparing nutrients in larval feeds.

Unit III

Biology of live feeds: Important live feeds and their biological features, Identification of new live feeds, Live feed use in different forms, Advantages and disadvantages. Important microalgae, rotifers, artemia, infusoria, cladocerans, copepods, oligochaetes, nematode and insect larvae. Bio-enrichment of live feed, Biofilm/periphyton and its use, Culture of single cell proteins and their nutritional quality.

Unit IV

Live feeds research in India, Around the world, New techniques developed in live feed use. Quality determination and cost benefit analysis, Production methods for different micro feeds, lab analysis of quality.

Practical

Collection, identification and isolation of live feed using various techniques, Preparation of various culture media, Preparation and maintenance of stock microalgal culture; Preparation of formulated feeds for rearing finfish and shellfish larvae; Mass culture of microalgae, cladocerans, copepods and rotifers; Hatching of artemia and enrichment; Culture of infusoria, earthworms and chironomid larvae; Evaluation of different prepared feeds.

AQC 509

Aquaculture Engineering

1 + 1

Objective:

To learn basic aspects of different aquaculture farm designing for effective management and optimum yield.

Theory

Unit I

Site selection: Criteria for site selection, Correction factors, Survey methods, Earth work calculations and cost estimation; water resources and their suitability, Suitability of soil from stability and productivity point of view; Land conversion effects and Environmental Impact Assessment (EIA).

Unit II

Estimation in farm construction: Area and volume calculations for an aquafarm and water bodies, surveying and leveling (chain, compass and plain table survey, dumpy level and the odolite).

Unit III

Design, layout planning and construction of different types of production systems: Types of ponds, shape, size and orientation, Design of embankments, Ponds and tanks, Water distribution, canals and exchange structures (inlets, outlets, sluice gates, and monks); Design of feeder channels and drainage systems. Pens, cages (fixed, floating, semi-submerged and tray cages) raceways, Flow-through systems and re-circulatory aquaculture systems (RAS), aquaponics, Feed dispensers, Demand feeders and effluent treatment systems (ETS), Automation in aquaculture.

Unit IV

Design and construction of hatcheries: (carp, freshwater prawn, shrimp and trout). Selection of aquaculture equipment and implement: Selection criteria and maintenance of water pumps, Water filtration systems, Principles of aeration, Aerators, Oxygen budgeting, Aeration grid, Automatic and demand feeders, Soil and water samplers. Aquifers, soil permeability, Hydraulic conductivity, Water budgeting, Water harvesting, Multiple uses of water, Economic impact of modernization in aquafarms

Practical

Estimation in construction, Model development, Visit to aqua farms and hatcheries, Survey - contour survey and mapping, chain and compass survey, Dumpy leveling, Evaluation of performance of seepage control measures, Layout planning and design of hatcheries (carp, freshwater prawn, shrimp and trout) and farms including their costing and evaluation, Estimation of pump capacity, Estimation of construction cost of ponds, Hatchery shed, Aeration devices and Evaluation of their capacity.

AQC 510

Open Water Aquaculture

1 + 1

Objective:

To learn about the open water aquaculture for production enhancement

Theory

Unit I

Introduction: Overview of global scenario of aquaculture in open waters, open water resources in India, Present status, Utilization, Prospects of production augmentation, Utilization of open water bodies for aquaculture to enhance production

Unit II

Different culture systems: Cages, pens and enclosures in open waters, Seed stocking, quality and quantity, Cages for sea, estuaries, reservoirs, lakes and canals, Pen culture, Selection of site for sea farming, Different designs of open sea farming structures-construction of cages-bioengineering problems and solutions, Species selection for open water aquaculture, Rearing of fingerlings, advanced fingerlings and table size fish in open water bodies.

Unit III

Practices: Ranching in open waters, species quality and quantity, Natural feed enhancement, Supplementary feeding in cages, Stock assessment, Harvesting and

conflicts with irrigation, Drinking water and hydroelectric projects on open water farming.

Unit IV

Environmental impact of Open water Aquaculture: Salinity intrusion, Effluent, discharge, Eutrophication, Chemical residues including antibiotics and hormones, Destruction of natural habitat including paddy field and mangroves, Social issues and conflicts with other users on resources

Practical

Different types of cage materials, fabrication of cages and pens and their installation. Determination of stocking density in cages and pens, Feeding in cages and pens, Stock assessment in cages and pens; Environmental impact of cages and pens, Visit to cages and pen sites.

AQC 511 Commercial Ornamental Fish Breeding and Culture 1 + 1

Objective:

To gain knowledge on advanced ornamental fish production technologies and aquatic ornamental plant propagation.

Theory

Unit I

Introduction: Global status of ornamental fish trade, present status and prospects of ornamental fish farming and trade in India, Indian ornamental fish diversity and its status, Prospects of production of new strains / varieties, Ornamental fish breeding techniques towards strain development.

Unit II

Design and construction: Self-maintained aquarium, species compatibility, High value species, Aquarium maintenance and care, Common aquarium plants and their identification, Gadgets used in freshwater and marine aquarium, aerators, Filters (UV, trickling and biofiltration), Protein skimmers, Ozonizer, thermostatic heater, Chiller, Lighting, Water conditioners, etc.

Unit III

Captive Breeding techniques: Mass production of commercially important freshwater and marine ornamental fishes, Nursery and grow out culture of commercially important ornamental fish species in Raceways, RAS etc., Hybrids development, Feed and feeding, color enhancement through pigmented feed, Novel feeds, Common diseases, and control, Water quality management.

Unit IV

Transportation and Trading of Ornamental Fishes: Medicines and chemicals used in the ornamental fish industry, Anaesthetics, packing, transportation and marketing strategies. Culture unit for entrepreneurship development, Socio-economic upliftment through backyard ornamental fish farming, Micro-traders in ornamental fish marketing.

Practical

Identification of common ornamental fishes; Plants and gadgets used in aquariums; Breeding of commercially important ornamental fishes, Visit to ornamental fish units,

Aquarium fabrication, Setting and maintenance, Application and use of medicines/chemicals.

AQC 512 Computer Application In Aquaculture Data processing 0 + 1

Objective:

To understand the scope on the computer application in the aquaculture process flow and systems

Practical

Computer application basics; Different common software installation and application; Identification of farm based software; Installation and application; Application of SPSS, SAS, SYSTAT and STATISTICA for analysis and presentation of fisheries data; Basic concepts of database management systems: Introduction to MS-ACCESS, ORACLE (RDBMS); Exercise on analysis of data using MS-EXCEL, SPSS, SAS, FISAT, SYSTAT and STATISTICA; Creation of Database using MS-ACCESS, ORACLE, Linear modelling of Feed formulation software installation and use.

AQC 513 Inland Saline Aquaculture 1+ 1

Objective:

To understand the scope for expanding aquaculture in inland saline waters for effective use

Theory

Unit I

Introduction: Inland saline waters, surface and ground water, Quality parameters of inland saline water in India, Global and national status of inland saline soils and underground saline water, Causes and process of salinization, geo-morphological changes, Problems of salinization, Potential for aquaculture.

Unit II

Soil and water characteristics: Comparison with coastal waters, Ionic amendment, water conditioning, Technological and engineering interventions for water quality improvement, Nutrient sparing and chelation in inland saline water.

Unit III

Potential candidate species: Sea bass, pearl spot, milk fish, mullet, shrimps, freshwater prawn, tilapia, cobia, pompano and selective carps for culture, Constraints and solutions, Alternate species with breeding possibilities, Metabolic interactions and growth promotion in altered water systems, Different farming systems.

Unit IV

Socio-economic Importance of Inland Saline Aquaculture: Nutritional intervention in inland shrimp farming; Economics of various finfish and shellfish culture in inland saline arenas; Integrated inland saline aquaculture systems; Recommendations for an action plan.

Practical

Inland saline soil and water sample collection, analysis and ionic amendments, Visit to inland saline water farms, Case studies of inland saline farms, Evaluation of different systems with regard to species cultured, Trials with different species in known inland saline water bodies.

AQC 514 **Multilevel Integrated Aquaculture Systems** **1+ 1**

Objective:

To gain knowledge on advanced integration practices along with aquaculture for enhancing aquaculture production.

Theory

Unit I

Integrated fish farming: Global status, integration with agricultural (paddy), horticultural crops (vegetable and fruits) and livestock (cattle, poultry, ducks, pigs and other terrestrial animals). Effective recycling of wastes, nutrient budgeting in different integrated farming systems. Production levels and economics.

Unit II

Bioprocessed manures in integration: Vermicompost, farmyard manure/ compost, biogas slurry, etc. Advantages of biomanures, Control of microbial interactions, Fermentation of manures.

Unit III

Concepts: Integrated multitrophic aquaculture systems and design of an IMTA unit, Aqua tourism. Aquaponics: concept, Principles, types and operation, Multilateral interaction and reserve management

Unit IV

Bio-resource flow in integrated aquaculture system: Discharge of nutrient wastes from integrated aquafarms; environmental effects, and potential for integrated multitrophic aquaculture, An economic analysis of different integrated culture systems.

Practical

Preparation of vermicompost; Analysis of nutrient value of different manures; Design of various integrated farming models; Different models of aquaponics; Nutrient analysis and management in aquaponics; Visit to integrated farms; Economics of different integrated systems with case studies.

AQC 515 **Cold Water Aquaculture and Recreational Fisheries** **1+ 1**

Objective:

To learn about the breeding and culture of different cold water fishes and their importance as sport fisheries or sport fish

Theory

Unit I

Introduction: Status of cold water fisheries in World with special reference to India, Biology, breeding and culture of trouts (*Oncorhynchus mykiss*, *Salmo truttafario*, *Schizothorachthys esocinus*, *S. longipinnis*, *S. niger*, *Schizothorax richadsonii*), Mahseer (*Tor putitora*, *Tor tor*, *Tor khudree*), Common carp (*Cyprinus carpio cummuinis*, *Cyprinus carpio specularis*). Specific environmental parameters pertaining to cold water fish culture and metabolic interaction, Feeds suitable for cold water aquaculture.

Unit II

Culture of coldwater fishes: Construction and management of coldwater fish farms, Effect of exotic fish introduction on indigenous fish fauna, Polyculture of exotic carps

in mid hill region based on three Chinese carps, post-harvest and harvest issues in trouts with regards to cold water species, Special factors for consideration in cold water fish seed production and nursery rearing.

Unit III

Introduction to sport fisheries: Sports fishes and their life history, Equipments for sports fishing, fishing methods, area suitable for sports fishing, etc. Management and conservation of sports fisheries through aquaculture, Sport fisheries and tourism, recreational aquaculture.

Unit IV

Issues and Desired Interventions: Potential and Innovative Strategies for the Development of Cold water Aquaculture in India- problems encountered in fisheries development of rivers supporting cold water fisheries.

Practical

Identification of cold water fish species; Primary and secondary sexual characters in coldwater fishes; Different breeding methods for coldwater fishes; Identification of larval stages of trout and mahseer; Preparation of hatchery layout for coldwater fishes; Studies on different types of sports fishing equipment; Visit to cold water fish hatchery.

AQC 516

Recirculating Aquaculture Systems

1+ 1

Objective:

To gain complete knowledge about the recirculating aquaculture systems and its recent developments

Theory

Unit I

Introduction: Evolution of intensive culture technologies, Need for intensification in aquaculture, Land and water constraints, Conflicts between enterprises for water use, Need for RAS, Current status and prospects of RAS in world with special reference to Asian countries.

Unit II

System engineering: Basic needs for the construction of RAS, Design of RAS, water re-use methods, Water budgeting, culture tanks, shape and size, Special features, waste solids removal, Cornell dual-drain system, Settling basins and tanks- design, Fabrication and construction, Water collection and sludge removal

Unit III

Filters: Mechanical filters, Biofilters- trickling towers, Floating bead filters, Fluidized sand beds, Down flow micro-bead biofilter, Moving bed bioreactors; aerators.

Unit IV

Management of RAS: Waste management, feeding management. Animal health management in RAS. Economic viability of RAS for various commercially important finfishes. Challenges in uplifting RAS practices

Practical

Species for RAS; Calculating stocking density of fishes in RAS; Determining the controlling flow rate; Calculating required design flow rate for DO; Calculating tank sizes; Feeding management in RAS; Waste water management in RAS; Visitto RAS units

b. Master's Programme

2) Discipline: Fish Nutrition and Feed Technology

Major courses (20 credits):

Course Code	Semester	Course Title	Credits
FNT 501*	I	Principles of Fish Nutrition	2+1
FNT 502*	I	Nutrient Digestion and Growth	2+1
FNT 503	I	Feeds and Feed Technology	2+1
FNT 506	I	Feed Ingredients and Additives	2+1
FNT 504*	II	Nutritional Energetics	2+1
FNT 505*	II	Nutritional Requirement and Feeding Management	2+1
FNT 512	II	Nutraceuticals	1+1
			13+7=20

*Compulsory Courses

Minor courses (8 Credits):

(Suggestive courses from the subjects closely related to a student's major subject)

FNT 508	I	Protein Nutrition	1+1
FNT 509	I	Lipid Nutrition	1+1
FNT 510	I	Carbohydrate Nutrition	1+1
FNT 507	II	Shellfish Nutrition and Feeding	2+1
FNT 511	II	Vitamins and Minerals Nutrition	1+1
			6+5=11

Courses relevant for student's research work or necessary for building his/her overall competence from following disciplines can be also taken as minor courses.

1. Aquaculture, 2. Fish Biotechnology, 3. Aquatic Environment management and 4. Fisheries Resource Management

Supporting Courses (6 credits): The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence can be taken. A few courses are suggested as under:

Course Code	Semester	Course Title	Credits
STAT 501	I	Mathematics for Applied Sciences	2+0
STAT 502	I	Statistical Methods for Applied Sciences	3+1
STAT 511	II	Experimental Designs	2+1
STAT 512	II	Basic Sampling Techniques	2+1
STAT 521	I	Applied Regression Analysis	2+1

STAT 522	II	Data Analysis Using Statistical Packages	2+1
MCA 501	I	Computers Fundamentals and Programming	2+1
MCA 502	II	Computer Organization and Architecture	2+0
MCA 511	I	Introduction to Communication Technologies, Computer Networking and Internet	1+1
MCA 512	II	Information Technology in Agriculture	1+1
BIOCHEM 501	I	Basic Biochemistry	3+1
BIOCHEM 505	II	Techniques in Biochemistry	2+2

Common Courses (Non Credit) (5 credits):

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Information Services	0+1
PGS 502	I	Technical Writing and Communication Skills	0+1
PGS 503	II	Intellectual Property and its Management in Agriculture	1+0
PGS 504	I	Basic Concepts in Laboratory Techniques	0+1
PGS 505	II	Agricultural Research, Research Ethics and Rural Development Programmes	1+0

Some of these courses are already in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platforms. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HoD/BoS.

Master's Seminar (1 credit):

Course Code	Semester	Course Title	Credits
FNT 591	IV	Master's Seminar	0+1

Master's Thesis Research (30 credits):

Course Code	Semester	Course Title	Credits
FNT 599	III	Master's Research	0+15
FNT 599	IV	Master's Research	0+15
		Masters' Research	0+ 30

Course Contents

FNT 501	PRINCIPLES OF FISH NUTRITION	2 + 1
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Objective

To understand the basic principles of fish nutrition and the role of different nutrients.

Theory**UNIT I**

Protein nutrition: Protein and amino acids, Their specific functions, Classification and evaluation criteria of dietary protein (nutrient gain, nutrient efficiency, TGC, PER, NPU, BV, EAAI, chemical score), Protein deficiency symptoms.

UNIT II

Lipid nutrition: Lipids and fatty acids, Their specific functions, Classification and evaluation of lipid quality, Lipid deficiency symptoms.

UNIT III

Carbohydrate nutrition: Carbohydrates, Functions, Classification and Utilization of carbohydrate in fish diets.

UNIT IV

Vitamin and mineral nutrition: Specific functions, Classification, Sources of vitamins and minerals and their deficiency symptoms.

UNIT V

Nutritional energetics: Definition, Different forms of energy and energy value of feed (gross energy, digestible energy, metabolizable energy, net energy), Importance of protein-energy ratio in fish diets.

UNIT VI

Larval and Brood stock nutrition: Larval gut morphology, importance of live feed and formulated feeds in larval nutrition, Nutrients required for egg and sperm quality and reproductive efficiency.

Practical

Proximate analysis: Moisture, Crude protein, Crude lipid, Gross energy, ash, acid insoluble ash, crude fibre, nitrogen free extract of feed and fish tissue, analysis of fatty acids and amino acids, calcium, phosphorus, vitamin C content of feed.

FNT 502**NUTRIENT DIGESTION AND GROWTH****2+1**

Objective: To understand digestion, absorption and transportation of nutrients and nutrient-induced growth in fish and shell fish

Theory**UNIT I**

Digestive system of fish: Digestive organs and their roles, Anatomy and histology, Feed ingestion, Feeding mechanism, Gastro-intestinal motility.

UNIT II

Digestive system of shellfish: Digestive organs and their roles, Anatomy and histology, Feed ingestion, Feeding mechanism, Gastro-intestinal motility.

UNIT III

Digestion: Digestion of proteins, Lipids and carbohydrates, Methods of determining digestibility; Direct and indirect methods, Advantages and disadvantages of methods, Digestibility value of feed ingredients and Factors affecting digestibility, Role of gut micro flora in digestion.

UNIT IV

Absorption and Transportation: Active, passive and facilitated absorption of nutrients, Transport of nutrients and cellular uptake.

UNIT V

Regulation of digestion: Appetite and satiation, Factors influencing appetite and satiation, Hormonal regulation and Factors affecting digestion.

UNIT VI

Growth: Concept of growth, Growth curve, Biotic and abiotic factors affecting growth, Correlation of growth with body weight and length.

Practical

Dissection and examination of digestive organs; Histological preparation of digestive organs; Assays of enzyme activity of amylase, proteases and lipases; In vivo - in vitro digestibility studies.

FNT 503

FEEDS AND FEED TECHNOLOGY

2+1

Objective To learn basic concept of feed formulation and different feed processing techniques

Theory

UNIT I

Feed formulation: General principles and criteria, Different methods of feed formulation; Pearson's square method and least cost formulation (quadratic equation, solver function, Graphic solution, Linear programming and software assisted formulations), Limitations of formulation methods.

UNIT II

Types of feed: Wet, Moist and Dry (pellets – steam compressed, extruded and crumbled, flakes, powdered/ mash, micro-encapsulated, micro-bound and micro-coated diets). Farm made feeds, Experimental diets; Reference diet, purified and semi-purified diet, Compact pellet, Floating and slow sinking pellet feeds; Starter,

grower, Finisher and broodstock feeds, High energy eco-friendly and medicated feed.

UNIT III

Feed processing technology: Receiving of raw materials, Equipments used in feed manufacture and processing; Grinder/pulverizer, Mixer, Pelletizer/extruder, Crumbler, Drier, Vacuum coater/ fat sprayer, automatic bagging and sealing, Role of pre-conditioning in feed preparation, Effects of processing on the nutritional value and availability of nutrients.

UNIT IV

Feed storage: Hydro-stability of feed and their storage; Prevention of spoilage from rancidity, Fungus and associated toxins; Vectors of fish disease in feed and quality control; Nutritional value in relation to feed storage.

UNIT V

Feed additives and supplements: Binders, carotenoids, Attractants, Antioxidants, Probiotics, Prebiotics, Synbiotics, Immunostimulants, Nutraceuticals, Acidifiers and Preservatives, Bile acids, Herbal additives and Vitamins, minerals, Limiting amino acids, Essential fatty acids, Phospholipids, and Cholesterol.

UNIT VI

Quality control in fish feed manufacturing: Quality control procedures, Raw materials, Finished products; Safety of farm fish products, Harmful residues (pesticides, antibiotics, and pollutants).; Geometrical, and physical feature; Mechanical characteristics in air, Behavioural characteristics in water, Feed economics and evaluation.

Practical

Feed formulation, Preparation of mineral and vitamin premix, Feed additives, binders, water stability test, and available lysine, Determination of feed particle size, Development of feed dispensers both for laboratory and pond feeding as part of project assignment, Visit to feed processing industries.

FNT 504

NUTRITIONAL ENERGETICS

2+1

Objective: To study nutritional energetics of different macromolecules and energy producing pathways.

Theory

UNIT I

Concepts of nutritional energetics: Energy budget equation; Energetic efficiencies and energy flow/partitioning in biological systems; Gross energy, Digestible energy, Metabolizable energy, Net energy, Heat increment of feeding (specific dynamic action, SDA); Factors influencing energy metabolism.

UNIT II

Energy requirement: Energy requirement of fish and shellfish, Factors influencing energy requirements; Energetics of maintenance and methodology of estimating the maintenance requirement.

UNIT III

Energy estimation: Direct and indirect methods of estimation of energy of feed and feed components based on chemical compositions.

UNIT IV

Energetics of growth: Relationship between feeding and growth; Energy exchange in biological systems; Growth and maturation

UNIT V

Energetics of reproduction: Gonadal maturation and reproduction in relation to feeding

UNIT VI

Energetics of intermediary metabolic pathways: Aerobic and anaerobic glycolysis, TCA cycle, Glycogenolysis, Beta oxidation, Electron transport chain, Effect of biotic and Abiotic factors on energy metabolism.

Practical

Estimation of gross and digestive energy of feed and feed ingredients; Estimation of digestibility of nutrients, Bomb-calorimetry; Energy budget equation based on experimental data; Determination of standard metabolism in fish; Assay of metabolic enzymes.

FNT 505 NUTRITIONAL REQUIREMENT AND FEEDING MANAGEMENT 2+1

Objective:

To learn nutritional requirements, feeding methods and feed management of commercially important fish and shellfish.

Theory

UNIT I

Nutritional requirements of finfish and shell fish: Nutritional requirements of larvae, growout and broodstock of commercially important finfish and shellfish. Methods of studying nutritional requirements; Qualitative and quantitative methods; Nutrients deficiency symptoms.

UNIT II

Nutritive value of live food: Algae, Artemia, Cladocerans, Ostracods, Rotifers and copepods, Bio enrichment of artemia and zooplankton, Experimental diets; Reference diet, Purified and Semi-purified diet.

UNIT III

Response indices for nutrient requirement studies: Weight gain, Specific growth rate (SGR)/ daily growth coefficient (DGC), Thermal growth coefficient (TGC) and, feed conversion ratio (FCR), Protein efficiency ratio (PER), Net protein utilization

(NPU), Physiometabolic parameters, Dose response curves, Gonadosomatic index (GSI)

UNIT IV

Body composition of fish and shellfish: Influence of nutrients on body composition and flesh quality; Effect of rations on fecundity and egg quality.

UNIT V

Feeding methods and devices: Broadcasting, Bag feeding, Tray feeding, Raft feeding, demand feeder, Mechanical automatic feeder, Blower feeder. Check tray feed monitoring, Ration size/ feeding rate and feeding frequency, Restricted feeding and mixed feeding.

UNIT VI

Feeding management: Application of research findings to farming situations, Record keeping, Growth prediction and Feeding management.

Practical

Determination of feed intake in fry and fingerlings; Determination of nutrient requirements of fish/prawn using purified diet; Analysis of experimental data from growth study; Measures of protein quality (PER, NPU, BV); Exercise on feeding.

FNT 506	FEED INGREDIENTS AND ADDITIVES	2+1
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Objective:

To learn the requirement and availability of ingredients for aqua-feed and different types of additives used.

Theory

UNIT I

National and international scenario: Present production trend and future requirements of feed ingredients, International coding of feed ingredients.

UNIT II

Ingredient classification: Conventional and unconventional feed ingredients, Plant (protein and energy-carbohydrate and lipid) and Animal (protein and energy- lipid) sources.

UNIT III

Quality evaluation of feed ingredients: Physical, Chemical (proximate composition, amino acids, EAAI, chemical score, fatty acids, vitamins and minerals profile and energy estimation, Anti- Nutritional Factors (ANFs) and other adventitious toxins) and Biological methods, Classification, Mode of action and Methods of detoxification of ANFs, Adulterants in feed ingredients.

UNIT IV

Feed additives and supplements: Classification, Function; Gustatory stimulants and feed attractants; Nutraceuticals, Non-nutrient feed components.

UNIT V

Feed raw material storage and spoilage: Grain storage, Liquid storage, Meal storage and Vitamin storage methods and practices, Prevention and management of raw material spoilage, Factors responsible for spoilage, Design criteria of storage shed, Silos, Bins, Roof ventilation and Aeration management etc., Temperature Monitoring, Silo Aeration system management and fumigation system to prevent spoilage.

UNIT VI

Enhancing nutrient status of feed raw material: Application of genetic engineering and production of genetically modified plant ingredients. Amino acids deficient in plant ingredients. Manipulating biosynthesis pathways to enhance essential amino acids in plant ingredients.

Practical

Identification of feed ingredients; Amino acid analysis of feed ingredients; Estimation of gross energy; Estimation of ANFs (Tannin, gossypol, phytate, protease inhibitors, cyanogens) and aflatoxin

FNT 507

SHELLFISH NUTRITION AND FEEDING

2+1

Objective:

To study the nutritional requirements of shellfish, feed formulation and feeding strategy

Theory

UNIT I

Nutritional requirements: Protein, carbohydrate, Lipid, Vitamin, Mineral, Essential amino acid, Fatty acid at various life stages, Methods for determining nutrient requirements, Factors affecting nutritional requirements.

UNIT II

Energy requirements: Protein-energy ratio, Protein sparing and methods for determining energy requirement and factors affecting energy requirements.

UNIT III

Food and feeding: Food and feeding habits, Natural food organisms, Micro-particulate diets (MBD, MCD, MED, MEM, PARA) for hatcheries; Grow-out and finisher feeds; Broodstock feeds for conditioning, Maturation and reproduction.

UNIT IV

Digestion, absorption and metabolism: Feed ingestion and feeding mechanism, Digestion, Absorption and Assimilation of nutrients, Gastro-intestinal motility, Factors affecting digestibility; Importance of microbial digestion.

UNIT V

Feeding management: Ration size/feeding rate and feeding frequency; Feed dispensing methods and devices.

UNIT VI

Feed Additives and health: Role of feed additives in shellfish nutrition, Immunity and health, Nutrient deficiency diseases in shellfish.

Practical

Study of digestive system of shrimps, prawns, lobsters, crabs; Formulation and preparation of diet with specific additives; nutrient requirement study in crustacean; water stability test

FNT 508

PROTEIN NUTRITION

2+1

Objective:

To understand the role of protein in aquafeeds and relationship of protein with energy metabolism

Theory

UNIT I

Protein requirement and their sources: Conventional and non-conventional, Plant and animal origin; Non-protein nitrogen; Protein requirement for maintenance, Growth and reproduction, Essential and non-essential amino acids, Amino acid antagonism, Protein and amino acid deficiency symptoms.

UNIT II

Protein energy ratio: Factors affecting protein requirement, Importance of protein energy ratio (P/E Ratio).

UNIT III

Digestion, absorption and metabolism: Digestion of protein, Absorption of amino acids and Their metabolism; Amino acid pool and Protein turnover.

UNIT IV

Evaluation of protein quality: PER, NPU, BV, ANPU, Kjeldahl Nitrogen Conversion factors. Ideal protein concept.

Practical

Extraction and purification of protein, Microkjeldahl method; Estimation of protein by methods of Biuret, Lowry and Bradford, total free amino acids; In vivo and In - vitro protein digestibility

FNT 509

LIPID NUTRITION

1+1

Objective:

To understand the importance of lipids in aqua feeds and the relationship of dietary lipid and tissue lipid

Theory

UNIT I

Requirement of lipid and their sources: Terrestrial and aquatic origin; Optimum dietary lipid level; Essential fatty acid requirements for growth, Reproduction and health importance of other fat-soluble substances (vitamins, carotenoids etc.). Interspecies differences in lipid requirement.

UNIT II

Lipid metabolism: Lipid digestion, Absorption, Transportation/mobilization, Metabolism and storage, Protein sparing effect of lipids.

UNIT III

Lipids and their fatty acids: Role of lipids and essential fatty acids, Their qualitative and quantitative requirement.

UNIT IV

Lipids quality: Oxidation of fats/lipids, Antioxidants and evaluation of lipid quality, Deficiency symptoms.

Practical

Estimation of total lipids, phospholipids and free fatty acids, peroxide value, saponification number, iodine value Separation and quantification of individual fatty acids by GCMS.

FNT 510

CARBOHYDRATE NUTRITION

1+1

Objective:

To understand the importance of carbohydrate in aquafeed and their protein sparing effect

Theory

UNIT I

Sources: Carbohydrate sources and digestible energy supply, Role of digestible and non-digestible carbohydrates; Dietary levels of carbohydrate for carps and catfishes.

UNIT II

Digestibility and interactions with other nutrients: Carbohydrate digestibility, Factors affecting starch utilization, Carbohydrate and Interaction with other nutrients and protein sparing effect.

UNIT III

Constraints and utilization: Constraints of carbohydrate utilization in fish, Non-starch polysaccharides, Strategy to enhance carbohydrate utilization; Gelatinization, Exogenous amylases, Glucose Intolerance; Carbohydrates and immunity.

UNIT IV

Economic importance aquafeeds: Maximum and inclusion levels for different fish species, Uses of carbohydrates for low-cost feed formulations.

Practical

Estimation of starch gelatinization in different feed processing methods; Blood glucose estimation; Estimation of crude fibre and non-starch polysaccharides.

FNT 511	VITAMIN AND MINERAL NUTRITION	1+1
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Objective:

To learn the importance of vitamins and minerals in fish and crustacean nutrition

Theory

UNIT I

Vitamins: Classification and sources, properties and functions of water- and fat-soluble vitamins; Vitamin as co-enzymes and prosthetic groups of enzymes.

UNIT II

Vitamin requirements and sources: Vitamin requirements of different species; dietary sources of vitamins; factors affecting vitamin requirements; Loss of vitamins during feed processing and storage.

UNIT III

Vitamin deficiency: Manifestation of vitamin deficiency; Vitamin –mineral interactions. Hypo- and hyper-vitaminosis.

UNIT IV

Minerals: Classification and sources, macro, micro minerals and heavy metals toxicity. Minerals requirements for different aquaculture species, dietary sources of minerals, factors affecting mineral requirement; nutrient-minerals interaction; Mineral-Mineral interactions; manifestation of mineral deficiency

Practical

Estimation of zinc, phosphorus, magnesium, iron and vitamin A; preparation of vitamin and mineral premix; estimation of vitamin and mineral losses due to leaching

FNT 512	NUTRACEUTICALS	1+1
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Objective:

To understand the role of nutraceuticals in the physiological wellbeing of fish and shellfish

Theory**UNIT I**

Nutraceuticals/functional foods: Definition, Classification and scope in aquaculture

UNIT II

Benefits and modes of action of nutraceuticals: Immunomodulatory proteins, Peptides, Polysaccharides, Oligosaccharides, Herbal extracts/phytochemicals, Carotenoids, Nucleotides, Bioactive compounds from seaweeds etc.

UNIT III

Minerals as nutraceuticals: Zinc, Copper, Chromium, Manganese, and Selenium

UNIT IV

Role of nutraceuticals: Stress mitigation and Growth enhancement, Immunomodulation and disease prevention

Practical

Estimation of immunomodulatory parameters (lysozyme, NBT, MPO, antibody titre), estimation of antioxidant enzymes (SOD, catalase, GPx), extraction of bioactive compounds, in vitro antioxidant assay.

c. Bachelor Programme

Semester No.	Term No.	Course No.	Credits	Title of the course offered by the department
I	First	AQC 111	1+1	Principles of Aquaculture
I	First	AQC 112	2+1	Fundamentals of Biochemistry
II	Second	AQC 123	2+1	Freshwater Aquaculture
II	Second	AQC 124	2+1	Fish Nutrition and Feed technology
III	First	AQC 235	1+1	Fish Food Organism
III	First	AQC 236	1+1	Ornamental fish production and management
III	First	AHM 232*	1+1	Fish and shellfish Pathology
III	First	AHM 233*	2+1	Pharmacology
IV	Second	AQC 247	2+1	Coastal Aquaculture and Mariculture
IV	Second	AQC 248	1+1	Aquaculture in reservoir
IV	Second	AQC 249	1+1	Genetics and breeding
IV	Second	AQC 2410	1+1	Introduction to biotechnology and bioinformatics
IV	Second	AHM 244*	1+1	Fish and Shellfish health Management
V	First	AQC 3511	2+1	Finfish Hatchery Management
V	First	AHM 355*	1+1	Therapeutics in aquaculture

VI	Second	AQC 3612	1+1	Shellfish hatchery management
VII	First	AQC 471	0+10	Students READY Programme (ELP) - Aquafarming
VIII	Second	AQC 482	0+10	Students READY Programme (In plant training)

Course Curricula and syllabi of each subject:

1	AQC 111	Principles of Aquaculture	1+1	2
	Theory	Basics of aquaculture, definition and scope. History of aquaculture: Present global and national scenario. Aquaculture Vs. Agriculture. Systems of aquaculture - pond culture Pen culture and cage culture. Running water culture and zero water exchange system. Extensive, semi-intensive, intensive and super intensive aquaculture in freshwater and inland saline waters. Extensive, semi-intensive, intensive and super intensive aquaculture in brackishwater and marine water. Principles of organic aquaculture. Pre-stocking and post stocking pond management. Carrying capacity of pond and factors influencing carrying capacity. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integrated culture systems. Water and soil quality in relation to fish production. Physical, chemical and biological factors affecting productivity of ponds.		
	Practical	Global and Asian Aquaculture production statistics. Aquaculture production statistics- India. State wise Aquaculture production statistics- world and India. Freshwater Aquaculture resources of world and India. Brackishwater Aquaculture resources of world and India. Marine Aquaculture resources of world and India. Components of Aquaculture farms, Estimation of carrying capacity of farm. Practices on pre-stocking management. Estimation of soil pH and lime application. Practices on post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system. Estimation of organic matter content of soil. Estimation of Nitrite and nitrate content in soils. Analysis of manure		
2	AQC 112	Fundamentals of Biochemistry	2+1	3
	Theory	A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Carbohydrate chemistry: Structure, classification, functions (mono, di and polysaccharides) isomerism and mutarotation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Protein chemistry: classifications and functions. Classification, structure, function and properties of amino acids. Essential and non-essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Digestion and absorption of lipids. Lipid autoxidation. Significance		

		of Omega- 3 and Omega-6 fatty acids. Enzymes: nomenclature; classification; specificity. Mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones chemistry and function. Structure and functions of fat and water soluble vitamins. Vitamins –classification and functions. Minerals – classification and functions. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Protein synthesis. Energy changes in chemical reactions, reversible and irreversible reactions in metabolism.
	Practical	Preparation of normal solution of acid and base. Preparation of buffers and reagents. Qualitative determination of carbohydrates. Qualitative determination of proteins. Qualitative determination of lipids. Estimation of total nitrogen. Estimation of crude protein of fish tissue. Estimation of carbohydrate content in food. Extraction of total lipids in fish tissue. Estimation of lipid content in fish tissue. Determination of specific gravity of oil. Study of different enzymes in fish. Genetic code. Determination of saponification value. Estimation of iodine value. Determination of Free fatty acid value.
3	AQC 123	Freshwater Aquaculture
	Theory	Major species cultured in different parts of the world. Production trends and prospect in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, eservoirs etc. Nursery, rearing and grow-out ponds preparation and management-Control of aquatic weeds and algal blooms, Eradication of predatory and weed fishes, Liming. Fertilization/manuring, Use of bio fertilizers, Supplementary feeding. Water quality management. Selection and transportation of seed. Acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods- Indian major carps, Culture of Exotic carps, Culture of Air breathing fishes, Culture of cold water fishes, Culture of Freshwater prawns, Culture of Mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and bio fertilizer in aquaculture. Composite fish culture system of Indian and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfish and murels. Integration of aquaculture with agriculture/horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.
	Practical	Preparation and management of nursery ponds. Preparation and management of rearing and ponds. Preparation and management of grow-out ponds. Study on effect of liming on hydrobiology of ponds and growth of fish and shellfishes. Effect of manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection and identification of aquatic weeds. Control of aquatic weeds. Collection, identification and eradication of aquatic insects, Collection, identification and eradication of predatory and weed fishes, eggs and larval forms of fishes. Algal blooms and their

		control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Estimation of livestock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond Embankment. Workout of economics of different culture practices. Economics of different integrated farming systems.		
4	AQC 124	Fish Nutrition and Feed technology	2+1	3
	Theory	Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fishes. Principal nutrients and nutritional requirements of cultivable shellfishes. Nutritional energetics. Definition and forms of energy partitioning. Methods of feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, Forms of feeds: dry feeds, mashes, Forms of feeds: pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, Feed additives: pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants. Feed storage: use of antioxidants. Feed evaluation: feed conversion ratio, feed efficiency ratio, protein efficiency ratio, Net protein utilization and biological value. Feeding devices. Feeding methods. Non-conventional feed ingredients. Anti-nutritional factors. Digestive enzymes. Feed digestibility. Factors affecting digestibility. Nutritional deficiency diseases.		
	Practical	Estimation of moisture content of feed and feed ingredients. Estimation of protein content by Kjeldhal method. Estimation of protein by Lowery method. Estimation of crude fat content by Soxhlet method. Estimation of crude fibre content in feed Estimation of ash. Formulation and preparation of moist feed by using locally available ingredients. Formulation and preparation of flake feed by using locally available ingredients. Formulation and preparation of pelleted feed by using locally available ingredients. Determination of sinking rate of feed. Determination of stability of pellets. Estimation of gross energy content of feed. Estimation of digestible energy content of feed. Equipment's and machineries used in feed production. Effect of storage on feed quality. Visit to commercial feed plant.		
5	AQC 235	Fish Food Organism	1+1	2
	Theory	Importance of Live food and Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Biology, nutritive value, reproduction and culture of <i>Artemia</i> . Biology, nutritive value, reproduction, and culture of <i>Moina</i> . Biology, nutritive value, reproduction, and culture of <i>Daphnia</i> . Biology, nutritive value, reproduction, and culture of freshwater Infusoria. Biology, nutritive value, reproduction and culture of green algae. Biology, nutritive value, reproduction and culture of blue-green algae. Biology, nutritive value, reproduction, and culture of Rotifer. Biology, nutritive value, reproduction, and culture of Tubifex worms. Biology, nutritive value, reproduction and culture of Chironomide		

		larvae. Biology, nutritive value, reproduction and culture of Spirulina. Biology, nutritive value, reproduction, and culture of marine water Infusoria. Biology, nutritive value, reproduction, and culture of Diatoms. Biology, nutritive value, reproduction, and culture of Copepods. Biology, nutritive value, reproduction, and culture Earthworms. Importance of Bait fish and Forage fish.		
	Practical	Method of collection and identification of marine plankton. Method of collection and identification of marine zooplankton. Method of collection and identification of freshwater plankton and zooplankton. Isolation of plankton and zooplankton for stock culture. Mass culture <i>Chlorella</i> . Mass culture <i>Isochrysis</i> / <i>Nannochloropsis</i> . Mass culture of Rotifer. Mass culture of <i>Moina</i> . Mass culture of Copepod. Culture of Tubifex worms. Culture of Earthworm / Visit to earthworm culture unit. Culture of Chironomide larvae. Enumeration of plankton and zooplankton. Proximate composition analysis of live food organism. Decapsulation of <i>Artemia</i> cyst by using bleaching powder and sodium hypochlorite solution Hatching of <i>Artemia</i> cysts and harvesting of <i>Artemia</i> nauplii.		
6	AQC 236	Ornamental Fish Production and Management	1+1	2
	Theory	World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filtration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Brood stock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.		
	Practical	Identification of common ornamental fishes and plants. Identification of common ornamental plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium. Setting up and maintenance of accessories and equipment. Conditioning of ornamental fishes. Packing of ornamental fishes. Preparation of flake feed Preparation of moist feed. Setting up of breeding tank for live bearers. Setting up of breeding tank for barbs. Setting up of breeding tank for goldfish. Setting up of breeding tank for tetras. Setting up of breeding tank for cichlids. Setting up of breeding tank for gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.		
7	AHM 232*	Fish and shellfish Pathology	1+1	2
	Theory	Explanation/Definition of some common terms, used in pathological studies. Host, Pathogen and Environment Interaction. Disease development process. Pathological processes: Cellular response to injury, Inflammatory response to diseases. Pathogenicity mechanisms of parasite. Pathogenicity mechanisms of Bacteria. Pathogenicity mechanisms of Virus. Pathogenicity mechanisms of Fungus.		

		<p>Infectious diseases of cultured finfish and shellfish. Non-infectious diseases of cultured finfish and shellfish.</p> <p>Important disease epizootics of wild fish population. Zoonotic diseases. OIE listed and notifiable diseases. Morphology, biology and life cycle of parasites.</p>			
	Practical	<p>General procedure for disease diagnosis. Methods of sampling fish for disease diagnosis</p> <p>Methods of sampling shellfish for disease diagnosis. Live and post mortem examination of fish. Live and post mortem examination of shellfish. Preparation of permanent and whole mounts. Sampling, preparation of media for pathogenic bacteria. Culture of pathogenic bacteria. Preparation of media and culture for Fungi. Preparation of media and culture for Viruses. Histological techniques. Haematological techniques. Identification, taxonomy and lifecycle of fish parasites. Identification, taxonomy and lifecycle of shellfish parasites. Morphology of fish and shellfish parasites.</p>			
8	AHM 233*	<table border="1"> <tr> <td>Pharmacology</td> <td>2+1</td> <td>3</td> </tr> </table>	Pharmacology	2+1	3
Pharmacology	2+1	3			
	Theory	<p>Introduction to Pharmacology: History, Importance, Terms and Definitions. Drug development, Screening and Nomenclature. Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs. Pharmacotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and Excretion of drugs. Factors influencing drug metabolism. Pharmacodynamics. Principles of drug action. Concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism.</p> <p>Second messenger. Non-receptor mediated action. Dose Response Relationship, half-life withdrawal period, potency, efficacy. Threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action. Adverse drug effects. Drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system. Nervous system, Cardiovascular system. Drugs used in fish transportation. Recent advances in Pharmacology. Biostatistics in experimental Pharmacology. Pharmaceutical industry.</p>			
	Practical	<p>Introduction to Pharmacy. Metrology. Prescription Writing. Preparation of drug solution.</p> <p>Source and chemical nature of drugs. Incompatibility. Pharmaceutical technology. Bioassay of drugs. Animal models in Pharmacological experiments. Methods of application of drugs in fish.</p>			
9	AQC 247	<table border="1"> <tr> <td>Coastal Aquaculture and Mariculture</td> <td>2+1</td> <td>3</td> </tr> </table>	Coastal Aquaculture and Mariculture	2+1	3
Coastal Aquaculture and Mariculture	2+1	3			
	Theory	<p>An overview of sea farming in different parts of the world. An overview of shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture in India. Resources for sea farming in India. Culture practices of seabass. Mullet culture. Culture of milkfish. Culture practices of grouper. Culture of cobia. Culture practices of snappers and Pearlsport culture. Culture practices of tiger shrimp. Culture practices of white shrimp. Mud crab culture practices. Mussel culture. Culture of Clams. Oysters (edible and pearl oyster) culture. Lobster culture. Seaweeds culture. Seed resources. Shore based aquaculture system: traditional (pokkali, bheries. Shore based</p>			

		aquaculture system: gazanis, khazans. Semi- intensive aquaculture practice of commercially important species of fish and shellfish. Intensive aquaculture practice of commercially important species of fish and shellfish. Methods of Shellfish Culture: Rafts, racks, Cages, poles and ropes. Water quality management. Pond soil quality management. Estimation of growth and survival Estimation of pond productivity. Pearl culture. Sea ranching.
	Practical	Identification of important cultivable species of finfishes. Identification of important cultivable species of shellfishes. Identification of important cultivable molluscan species. Collection and identification of commercially important seed of fin fishes. Collection and identification of commercially important seed of shellfishes. Types of fertilizers - Pond preparation. Quality Seed selection. Seed acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.
10	AQC 248	Aquaculture in Reservoir
	Theory	Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and post impoundment stages and their significance in establishment of reservoirs fisheries. Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in Reservoirs fish production. Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs. Role of cage and pen culture in enhancement of fish production from reservoirs. History of cage culture, advantages of cage culture. Selection of suitable site of cage culture. Cage materials, designs, shape, size and fabrication. Cage frames and supporting system. Integration of cage culture with other farming systems. History of pen culture, pen materials, fabrication; breeding of fish in pen. Rearing of spawn in pen. Grow-out from pens. Suitable species for culture in cages and pens. Constraints in cage and pen culture. Economics of cage and pen culture.
	Practical	Preparation of charts on the present situation of reservoirs fisheries productivity in India. Preparation of charts on the present situation of reservoirs fisheries productivity in Maharashtra. Preparation of charts on the present situation of reservoirs fisheries productivity in Konkan region. Detailed case studies of selected reservoirs on the changing trends in capture fisheries profile. Estimation of the productivity of the reservoir. Fish species composition and production details. Types of nets, boats used in capture operation and number of fishers involved in trade. Water quality parameters. Demand and supply of fish. Economics of the capture operations. Drawing inferences from the analysis of data. Suggestions for the sustainable development of

		reservoirs fisheries. Case studies on cage culture. Case studies on pen culture. Field visit to cage culture site to acquaint construction details and operation. Field visit to pen culture site to study construction details and operation.		
11	AQC 249	Genetics and Breeding	1+1	2
	Theory	Principles of genetics and breeding. Gene and chromosome as basis of inheritance. Mendel's law of inheritance –complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes. Sex influenced and sex-limited traits. Linkage and crossing over. Introduction to population genetics. Hardy- Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) –types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes. Quantitative genetics –quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.		
	Practical	Problems on Mendelian inheritance (qualitative genetics) – monohybrid ratios. Problems on Mendelian inheritance (qualitative genetics) -dihybrid ratios. Problems on Mendelian inheritance (qualitative genetics) - epistasis. Problems on quantitative traits. Response to selection and heritability. Estimation of rate of inbreeding and heterosis. Estimation of inbreeding coefficient. Preparation of Selection index for selective breeding programme. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis. Demonstration of protocol of gynogenesis. Demonstration of protocol of polyploidy. Problems on gene and genotypic frequency. Quality evaluation of fish milt. Gamete cryopreservation protocols. Study of risk factors in cryopreservation technique.		
12	AQC 2410	Introduction to biotechnology and bioinformatics	1+1	2
	Theory	Biotechnology: Introduction to Biotechnology –scope and importance in fisheries/aquaculture. Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes. DNA sequencing, Operons. Genetic engineering- Restriction enzymes. Gene isolation. Cloning vectors. Probes. Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR. Immunoblotting, ELISA. Principle of hybridization. Northern blotting. Western blotting. Southern blotting. DNA fingerprinting. Restriction fragment length		

		polymorphism. Biosensors. Concept of bioremediation of water, bioprocess engineering and bio prospecting. Bioinformatics: Introduction to Bioinformatics, Biological Data bases and tools: Introduction. Types of biological databases. Primary and secondary databases PDB, NCBI, formats and contents Sequence retrieval, manipulation. Primer design. Restriction mapping. ORF finding. EMBOSS, Molecular visualization Sequence analysis.		
	Practical	Study of structure of prokaryotic cell. Study of structure of Eukaryotic cell. Study of DNA structure. Restriction enzymes. Isolation of DNA. Isolation of RNA. PCR amplification. Gel Electrophorus. Study on Model of protein Synthesis. Study of models DNA Technology. Cell Culture. Isolation of Nucleic Acids. ELISA. DNA sequence analysis and comparison. Study of data search engines. Study of different data bases.		
13	AHM 244*	Fish and Shellfish health Management	1+1	2
	Theory	Stress in aquaculture and its role in disease development. Prevention and control of infectious diseases of fish and shellfish. Prevention and control of non-infectious diseases of fish and shellfish. Quarantine and health certification in aquaculture. Health management strategies in aquaculture. Vaccines. Immuno-stimulants. Bioremediation. Use of probiotics. Crop rotation, Good and Best management practices. SPF stocks -development and application. SPR stocks -development and application. Sanitary and phytosanitary agreement. Importance of Biofilm. Importance of bio-flock. Periphyton in health Management.		
	Practical	Case history in disease diagnosis. Clinical signs in disease diagnosis. Methods of detection of stress factors. Methods to control stress factors. Techniques in disease diagnosis. Microbiological technique. Media preparations & Cell culture. Biochemical technique. Extraction of blood & serum separation. Immunological techniques. Molecular technique. Histological techniques. Challenge tests. Visit to finfish farm for health monitoring. Visit to fish shrimp farms for health monitoring. Disease surveillance and reporting.		
14	AQC 3511	Finfish Hatchery Management	2+1	3
	Theory	Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, Gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male. Development of gametes in female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warm water finfishes, Environmental factors affecting spawning, sympatric breeding. Hypophysation of fishes. Fish pituitary gland –its structure, collection, Preservation and preparation of extract for injection, dosages and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional. Study		


		of Chinese circular hatchery. Study of glass jar hatchery. Study of modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anaesthetic in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, Breeding techniques for tilapias, catfishes, grey-mullets, milk fish, Breeding techniques for pearl spot, sea bass, sea horse, Breeding techniques for groupers, pacu, cobia, Breeding techniques for pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps.		
	Practical	Study of maturity stages in fishes. Collection and preservation of fish pituitary gland. Preparation of PG extract. Hypophysation technique. Estimation of fecundity. Brood-stock management practices. Selection of brooders for injection. Histological studies of ovary and testes. Different fish hatchery systems. Study of fish eggs and embryonic developmental stages Identification of eggs, spawn of different species. Identification of fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anaesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.		
15	AHM 355*	Therapeutics in aquaculture	1+1	2
	Theory	Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents. Mode of action, general principles, classification. Antibiotics, different classes and their mode of action, properties etc. Antibiotic resistance. Antiseptics and disinfectants. Antiparasitics: Ectoparasites. Endoparasites. Protozoan. Antibiotics used in aquaculture. Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation. Mechanism of action, drug leaching, stabilizer, binders and dosage. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anaesthetics, flesh color enhancers, Chemicals of therapeutic value, Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices. List of the drugs used in aquaculture with therapeutics.		
	Practical	Regulations of drug use. Regulatory agencies. Introduction to antimicrobials. Preparation of potassium permanganate solution. Preparation of weak Tincture Iodine. Minimum inhibitory concentration (MIC). Five-plate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Calculation of different chemotherapeutant dosage in treating fish ponds. Calculation of different drug dosage in treating fish ponds. Generic name. Patent name. Dosage and indications of various aquaculture drugs used in fish health.		
16	AQC 3612	Shellfish hatchery management	1+1	2
	Theory	Natural seed resources, site selection and collection methods. Life		

		<p>cycle of important shellfish (<i>Penaeus monodon</i>, <i>P. indicus</i>, <i>Macrobrachium rosenbergii</i>, <i>P. vannamei</i>, <i>Scylla serrata</i>, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe crab, Sepia, Loligo, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of <i>Macrobrachium rosenbergii</i> and <i>Penaeus monodon</i> and <i>P. vannamei</i>. Induced maturation in <i>Penaeus monodon</i> and <i>P. vannamei</i> <i>P. indicus</i> by eye stalk ablation. Reproductive physiology. Reproductive hormones in crustaceans. Broodstock management of <i>Penaeus monodon</i> and <i>Macrobrachium rosenbergii</i>. Breeding and hatchery management of <i>Penaeus monodon</i> and <i>Macrobrachium rosenbergii</i>. Breeding and hatchery management of crabs lobster, mussel, edible and pearl oyster. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.</p>																	
	Practical	<p>Identification of brood stock and maturity stages of important crustaceans. Identification of brood stock and maturity stages of important molluscs. Observations on gonadal maturation of <i>Penaeus monodon</i>. Observations on gonadal maturation of <i>Macrobrachium rosenbergii</i>. Brood stock management of commercially important crustaceans. Breeding and larval rearing of <i>Macrobrachium rosenbergii</i>. Breeding and larval rearing of <i>Penaeus monodon</i>. Breeding and larval rearing of <i>P. vannamei</i>. Identification of larval stages of important crustaceans. Identification of larval stages of important molluscs. Demonstration of eyestalk ablation in <i>Penaeus monodon</i>. Collection, packing and transportation of shrimp/prawn seed. Collection, packing and transportation of broodstock. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.</p>																	
17	AQC 471	<p>Students READY Programme (ELP) - Aquafarming</p>	0+10	10															
		<table border="1"> <thead> <tr> <th>Major Topics</th> <th>Credits</th> <th>Duration (Week)</th> </tr> </thead> <tbody> <tr> <td colspan="3" style="text-align: center;">Experiential Learning: (0+6)</td> </tr> <tr> <td>Capacity building 1.1 Project formulation, Finance mobilization, Business management</td> <td>0+1</td> <td>1</td> </tr> <tr> <td>1.2 Identification of cultivable fish and shellfish, farming systems 1.3 Site selection criteria 1.4 Design and construction of ponds</td> <td>0+1</td> <td>1</td> </tr> <tr> <td>1.5. Reservoir pond and Effluent treatment system 1.6 Calculation of doses of chemicals and probiotics 1.7 Health assessment and management</td> <td>0+1</td> <td>1</td> </tr> </tbody> </table>	Major Topics	Credits	Duration (Week)	Experiential Learning: (0+6)			Capacity building 1.1 Project formulation, Finance mobilization, Business management	0+1	1	1.2 Identification of cultivable fish and shellfish, farming systems 1.3 Site selection criteria 1.4 Design and construction of ponds	0+1	1	1.5. Reservoir pond and Effluent treatment system 1.6 Calculation of doses of chemicals and probiotics 1.7 Health assessment and management	0+1	1		
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		1.8 Application of doses of lime, fertilizers	0+1	1															
		1.8 Harvesting, cost-benefit analysis	0+1	1															
		1.9 Report preparation, presentation and evaluation	0+1	1															
		Skill Development: (0+3)																	
		2.1 Analysis of soil quality parameters	0+1	1															
		2.2 Analysis of water quality parameters	0+1	1															
		2.3 Preparation of feed and Feeding management	0+1	1															
		Project Work and Seminar	0+1	Entire ELP duration															
		Total	0+10	10															
18	AQC 482	Students READY Programme (In plant) - Aquafarming	0+10	10															
	Practical	<table border="1"> <thead> <tr> <th>Activities</th> <th>Credit</th> <th>Number of weeks</th> </tr> </thead> <tbody> <tr> <td>Rural Awareness Work Experience (RAWE)</td> <td>0 + 4</td> <td>04</td> </tr> <tr> <td>Industry attachment</td> <td>0 + 5</td> <td>05</td> </tr> <tr> <td>Report Preparation, Presentation and Evaluation</td> <td>0 + 1</td> <td>01</td> </tr> <tr> <td style="text-align: right;">Total credits</td> <td>0 + 10</td> <td>10</td> </tr> </tbody> </table>	Activities	Credit	Number of weeks	Rural Awareness Work Experience (RAWE)	0 + 4	04	Industry attachment	0 + 5	05	Report Preparation, Presentation and Evaluation	0 + 1	01	Total credits	0 + 10	10		
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Industry attachment	0 + 5	05																	
Report Preparation, Presentation and Evaluation	0 + 1	01																	
Total credits	0 + 10	10																	


2. Faculty

- a. **Academic staff:** Assistant Professor and above with the details of the staff as given below


	Name of the Faculty member	Dr.Suresh Dattatray Naik
	Post Held	Professor & Head, Department of


		Aquaculture
Date of Birth		18/02/1963
Qualification		PhD (Fisheries)
Area of Specialization		Fisheries Biology, Aquaculture
Experience (Years)		32 years
Research Projects guided	03	
PhD	13	
M.Sc./M.Tech		
B.Tech.		
Present area of research		Aquaculture
Contact details		
Land line No.	02352-232241	
Mobile	8275454821	
Fax	232241	
Email	Naiksdn2003@yahoo.co.in	

	Name of the Faculty	Dr. Anil S. Pawase
	Post Held	Associate Professor
	Date of Birth	24/07/1968
	Qualification	Ph.D
	Area of Specialization	Aquaculture, Marine Fisheries
	Experience (Years)	23 yrs
	Research Projects guided	
	PhD	2
	M.F.Sc.	10
	Present area of research	Aquaculture
Contact details		
Land line No.	02352-232241	
Mobile	9422430498	
Fax	02352-232241	
Email	anilpawase@yahoo.com	


	Name of the Faculty	Dr. B. R. Chavan, Department of Aquaculture, College of Fisheries, Shirgaon
	Post Held	Professor Department of Aquaculture
	Date of Birth	15/06/1972


	Qualification	M. F. Sc. (CIFE, Mumbai), Ph.D (AIT, Thailand)
	Area of Specialization	Aquaculture
	Experience (Years)	22
	Research Projects guided	
	PhD	1
	M.F.Sc.	4
	Present area of research	Aquaculture,
	Contact details	
	Land line No.	-
	Mobile	7387326984, 8847756011
	Fax	-
	Email	brc15672@gmail.com


	Name of the Faculty member	Dr. SHASHIKANT JAYCHAND MESHARAM
	Post Held	Associate Professor (CAS)
	Date of Birth	03/07/1974
	Qualification	Ph. D. (Aquaculture)
	Area of Specialization	Freshwater Aquaculture, Fish nutrition, Immunology
	Experience (Years)	24 years
	Research Projects guided	Ph. D. 01
	PhD	M. F. Sc.
	M.Sc./M.Tech	05
	B.Tech.	
Present area of research	Freshwater Aquaculture, Fish nutrition, Immunology, Biofloc	
Contact details		
Land line No.	(9834408675)	
Mobile	-	
Fax	shashikantmesh90@gmail.com	
Email		

	Name of the Faculty	Dr. Gajanan S. Ghode
	Post Held	Associate Professor (CAS)
	Date of Birth	01-06-1974
	Qualification	Ph.D.
	Area of Specialization	Aquatic Animal Health Management


	Experience (Years)	18 years
	Research Projects guided PhD M.F.Sc.	NIL 04
	Present area of research	Surveillance of aquatic animal diseases
	Contact details Land line No. Mobile Fax Email	Department of Aquaculture 08424096660 02351-232278 gajananghode74@gmail.com

	Name of the Faculty	Dr. Raju M. Tibile
	Post Held	Associate Professor (CAS)
	Date of Birth	10/06/1976
	Qualification	Ph.D.
	Area of Specialization	Aquaculture
	Experience (Years)	19 yrs
	Research Projects guided PhD M.F.Sc.	NIL 06
	Present area of research	Ornamental fish production, aquaculture systems and practices
	Contact details Land line No. Mobile Fax Email	02352-232241 9422911176 rmtibile@gmail.com

	Name of the Faculty	Dr. Mrs. Sangita Suhas Wasave
	Post Held	Assistant Professor
	Date of Birth	28-08-1981
	Qualification	Ph.D.
	Area of Specialization	Aquaculture
	Experience (Years)	19 years
	Research Projects guided PhD M.F.Sc./M.Tech B.Tech.	Nil
	Present area of research	Aquaculture
	Contact details Land line No. Mobile Fax Email	+91 9421229401 sangitawasave@gmail.com

	Name of the Faculty	Dr. Varsha R. Bhatkar
	Post Held	Assistant Professor
	Date of Birth	08/03/1978
	Qualification	Ph.D
	Area of Specialization	Aquaculture
	Experience (Years)	22
	Research Projects guided	
	PhD	-
	M.F.Sc.	3
	Present area of research	Molluscan larvae culture
Contact details		
Land line No.	+91 2352-232241	
Mobile	+91 9420842753	
Fax	+91 2352-232241	
Email		

b. Research staff: The name of the research staff member like SRA and JRA.

	Name of the Faculty	Mrs. Archana S. Pawar
	Post Held	Senior Research Assistant
	Date of Birth	07/03/1984
	Qualification	M.F.Sc
	Area of Specialization	Aquaculture
	Experience (Years)	10 years
	Research Projects guided	-
	PhD	
	M.Sc./M.Tech	
	B.Tech.	
Present area of research	Aquaculture	
Contact details		
Land line No.	9370968811	
Mobile	archana114@rediffmail.com	

	Fax Email	
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3. A. Infrastructure

a. **Laboratories: Wet Laboratory**

b. **Name of the important instruments/facilities:** All-glass tanks, FRP tanks, air blowers

c. **Activities:** Practicals and PG research work with respect to aquatic animal breeding and rearing are undertaken

d. **Photographs:**



e. **Laboratories: Nutrition and disease diagnostic Laboratories**

f. **Name of the important instruments/facilities:** Digestion and distillation units, Spectrophotometer, PCR,



g. **Activities:** Practicals and research work of PG students and research projects are undertaken.

h. **Photographs:**



B. 1. Instructional Farm

- a. **Location:** Fish rearing Farm, Shirgaon
- b. **Infrastructure:** Ponds with freshwater supply

c. **Activities:** Rearing or maintenance of ornamental fishes in integration with vegetable crops

d. **Photographs**



2. Instructional Farm

a. **Location:** Shirgaon

b. **Infrastructure:** Brackishwater and freshwater ponds

c. **Activities:** Undertaking practicals of UG

d. **Photographs:**



4. Research Activities and Achievements (including projects)

a. **Variety/Implements released:** --

b. **Research Recommendations:**

c. **Research Outcome/Findings:** Provide the details of the important research findings/outcome of the research experiments conducted along with relevant photographs

d. **Completed Research Projects/Programmes/Schemes**

b. Research Recommendations:

Project 1: Experiments on the transportation of seeds of green mussel, *Perna viridis*

Objectives:

1. To compare degree of stress caused by transporting individually segregated mussels and bunches of mussel seed
2. To standardize packing density of mussel seed for transportation
3. To compare degree of stress caused by transporting mussels in air versus in water

4. To undertake field trial of mussel seed transportation by using the developed method

Name of PI/ Co-PI: R.M. Tibile, A.M. Ranade, H.T. Dhaker, S.T. Indulkar, D.I. Pathan, A.V. Deolalikar, G.S. Ghode

Sponsoring Agency: Dr. B.S. KKV, Dapoli

Duration: One year

Total Outlay: Rs. 5000/-

Recommendation:

It is recommended to pack segregated seed of green mussel, *Perna viridis* in moist gunny bags (90 x 60cm) at a density of 12 kg per bag for undertaking transportation for 36 hours.



Project 2: Spawning and larval rearing of neon tetra, *Paracheirodon innesi* (Myers, 1956)

Objectives:

1. To study effects of pH and egg hatching of neon tetra, *Paracheirodon innesi*
2. To study effects of feeding ration of mixed phytoplankton on growth and survival of free-swimming larvae of neon tetra

Name of PI/ Co-PI: R.M. Tibile, H.T. Dhaker, D.I. Pathan, G.S. Ghode

Sponsoring Agency: Dr. B.S. KKV, Dapoli

Duration: Two years

Total Outlay: Rs. 5000/-

Recommendation:

To spawn fish successfully and for better egg hatching of neon tetra, pH in the range of 5.5 to 6.5 while total hardness of 15-35 mg/l are to be maintained and feeding ration of mixed phytoplankton with a dominance of *Chlorella* at the rate of 2 lakh cells/ml/day is recommended for rearing free-swimming larvae of neon tetra at a density of 10 larvae/l for 15 days



Project 3: Effect of different stocking densities and feeding rations on growth and survival of *Liza parsia* (Hamilton- Buchanan, 1822) fry in cages

Objectives:

1. To find out optimum stocking densities for growth and survival of *Liza parsia* fry in cages
2. To know the optimum feeding ration of *Liza parsia* fry in cages

Name of PI/ Co-PI: G.S. Ghode, D.I. Pathan, R.M. Tibile, A.S. Pawase, B.R. Chavan and H.S. Dhaker

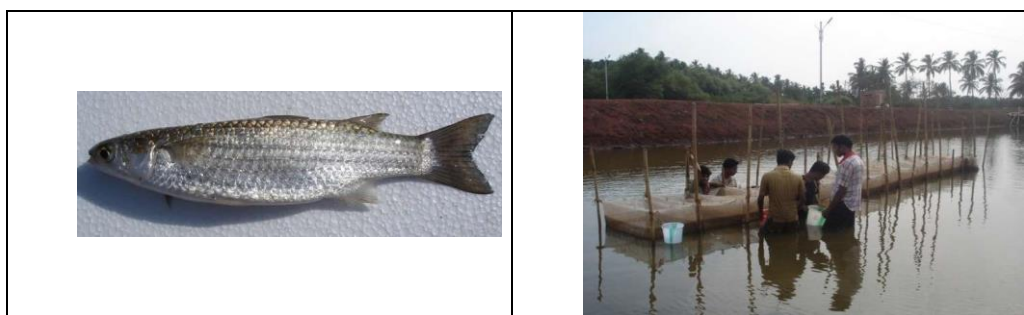
Sponsoring Agency: Dr. B.S. KKV, Dapoli

Duration: One year

Total Outlay: Rs. 5000/-

Recommendation:

It is recommended to stock fry of *Liza parsia* at the rate of 50 fry per m² with a feeding rate of 6% of body weight per day for achieving better growth and survival in cages for a period of 35 days



Project 4: Biological and stock assessment studies on some commercially important species occurring along Ratnagiri coast, Maharashtra state

Objectives:

1. To collect length frequency data and estimate the population parameters
2. Biological studies on sampled fish
3. To assess the exploitation level of commercially important fish stock

Name of PI/ Co-PI: A.S. Pawase, M.S. Sawant, S.K. Barve, R. Pai

Sponsoring Agency: Dr. B.S. KKV, Dapoli

Duration: Three years

Total Outlay: Rs. 5000/-

Recommendations:

It is recommended to reduce the fishing effort to get exploitation ratio 0.55 than the present exploitation ratio 0.61 for getting sustainable catch of White fish, *Lactarius lactarius*. In case of Indian Mackerel, exploitation ratio of 0.51 is observed to be optimum and needs to be maintained to get sustainable catches from Ratnagiri coast.

Project 5: Induced Breeding of *Pangasianodon hypophthalmus* (Sauvage, 1878)

Objectives: To undertake induced breeding of *Pangasianodon hypophthalmus*

Name of PI/ Co-PI: K.S. Sawant, V.R. Bhatkar, R. M. Tibile, D.I. Pathan, A. S. Pawase, Dr. Hukamsingh Dhakar

Sponsoring Agency: Dr. B.S. KKV, Dapoli

Duration: Three years.

Total Outlay: 40,000/-

Recommendation:

For induced breeding of pangasius it is recommended to use carp pituitary extract at the rate of 3 mg/kg and 10 mg/kg body weight of fish as first and second dose respectively for female at an interval of 8 hrs, while male to be injected at a rate of 3 mg/kg body weight at the time of second dose given to female. OR to use synthetic hormone sGnRH-A at the rate of 0.5 ml/kg body weight for female and 0.4 ml/kg body weight for male. OR to use human chorionic gonadotropin at the rate of 2000 IU/kg and 3000 IU/kg body weight of fish as first and second dose respectively for female at an interval of 8 hrs, while male to be injected at a rate of 1000 IU/kg body weight at the time of second dose given to female.

Project 6: Culture of *Labeo rohita* fry in biofloc system

Objectives:

1. To evaluate effect of different levels of suspended solids on survival and growth of rohu, *Labeo rohita* fry in biofloc system
2. To observe the growth and survival of *Labeo rohita* fry at different stocking densities in biofloc system

Name of PI/ Co-PI: R. M. Tibile, A.S. Pawase, B.R. Chavan, D.I. Pathan, S.J. Meshram, G.S. Ghode, Mrs. S.S. Wasave, K.S. Sawant and R. Pai

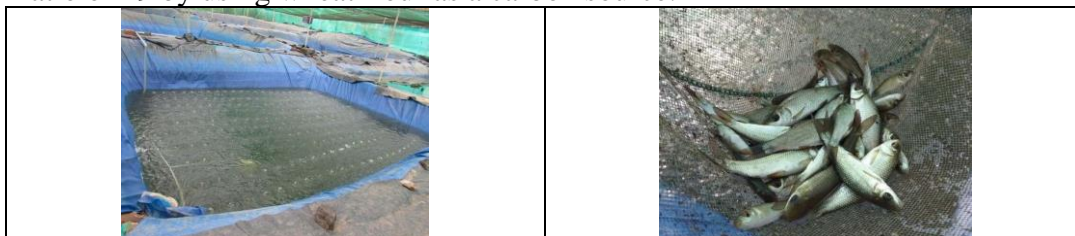
Sponsoring Agency: Dr. BSKKV

Duration: Three years

Total Outlay: Rs. 5000/-

Recommendation:

It is recommended to rear 15 fry of *Labeo rohita* (length - 20-25 mm) per 100 L for 90 days to achieve optimal growth and survival in biofloc system with C/N ratio of 19 by using wheat flour as a carbon source.

**7. AQ. CUL. 15 Studies on nursery rearing of tilapia in biofloc system**

- Principal Investigator : S. S. Wasave
- Co-Investigators: Dr. S. D. Naik, Dr. A. S. Pawase, Dr. B. R. Chavan, Dr. S. J. Meshram, Dr. G. S. Ghode, Dr. R. M. Tibile and Dr. V. R. Bhatkar
- Year of commencement: 2021-22
- Objective: 1. To study the growth and survival of tilapia fry at different stocking densities in biofloc system during nursery phase
- Sponsoring Agency: Dr. BSKKV
- Duration: Two years
- Total Outlay: Rs. 15000/-
- **Recommendation:**

It is recommended to stock Genetically Improved Farmed Tilapia (GIFT) fry (TL 2.5-3.5cm) at the rate of 75 to 100 numbers per cubic meter

for a period of 2 to 2.5 months to achieve better growth (9 to 10 g) in nursery biofloc system.

अशी शिफारस करण्यात येते
शिफारस: की, सुधारीत जनुकिय संवर्धित
तिलापिया (GIFT) च्या २.५ ते ३.५ से. मी. आकाराच्या बीजाचे बायोफ्लॉक
पध्दतीमध्ये ७५-१०० नग प्रति घनमीटर अशा घनतेने साठवणूक करून २ ते २.५
महिने संगोपन केल्यास उत्तम वाढ (९-१० ग्रॅ) मिळवता येते.

d. Completed Research Projects:

a. Institutional Projects:

1. COF/AQ CUL-04: A Case Study of Savitri Reservoir for Food Security and Rural Livelihood in Raigad District

- Principle Investigator: B. R. Chavan
- Co-Investigator: G. S. Ghode, R. M. Tibile and H. S. Dhaker
- Duration: 2 years
- Year of Commencement: 2010
- Objectives
 1. To collect baseline information for a better management of the aquatic impoundments.
 2. To determine the relationships between plankton production and fish production.

2. AQ.CUL: 05 Finfish seed resources in and around Ratnagiri coastal region for Capture Based Aquaculture

- Principal Investigator : Dr. A. S. Pawase
- Co –Investigators: V. R. Bhatkar, R. M. Tibile, D.I. Pathan and Dr. H. S. Dhaker Year of commencement : 2011
- Objectives:
 1. To find out the seasonal occurrence of finfish seed for the preparation of seed calendar.
 2. To assess the species composition of finfish seed resources.

3. AQ CUL 06: Observations on spat fall of edible oysters in Purnagad and Bhatye creek

- Principal Investigator : R.M. Tibile
- Co-Investigators: Dr. A.S. Pawase, Dr. D.I. Pathan, V.R. Bhatkar and Dr. H.T. Dhaker
- Year of commencement: 2011-12
- Objective:
 1. To observe spat settlement of edible oysters in Purnagad and Bhatye creek.

4. AQ.CUL 07: Induced Breeding of *Pangasianodon hypophthalmus* (Sauvage, 1878)

- Principal Investigator : Mr. Krupesh S Sawant.

- Co-Investigator: V. R. Bhatkar, R. M. Tibile, D I Pathan, A. S. Pawase, H.T. Dhaker,
 - Year of Commencement: 2012-13
 - Objective: Induced breeding of *Pangasianodon hypophthalmus* (Sauvage, 1878)
5. **AQ.CUL 08:** Assessment of culture potential of mud clam, *Polymesoda erosa* (Solander, 1876).
- Principal Investigator : Dr. A.S. Pawase
 - Co-Investigators: Krupesh S Sawant, Mrs. S.S. Wasave, R. M. Tibile, Dr. D.I. Pathan, and Dr. R. Pai.
 - Year of commencement: 2015-16
 - Objective: To study ecology, food preference, environmental parameters, growth studies and spawning trials.
6. **AQ CUL 05:** Nursery rearing of Jayanti rohu in the ponds of Kharland region in Ratnagiri.
- Principal Investigator : Dr. S. J. Meshram
 - Co-Investigators: Dr. R. Pai, Dr. A.S. Pawase, Dr. D.I. Pathan, Dr. G. S. Ghode, Dr. R. M. Tibile, Dr. S. S. Wasave
 - Year of commencement: 2016-17
 - Objective: To evaluate the growth and survival of Jayanti rohu seed in Kharland ponds
 -
7. **AQ.CUL 09:** Mass rearing of fairy shrimps under laboratory conditions
- Principal Investigator : Dr. A.S. Pawase
 - Co-Investigators: R. M. Tibile, Krupesh S Sawant, G.S. Ghode, Mrs. S.S. Wasave, Dr. S. J. Meshram, Dr. D.I. Pathan, and Dr. R. Pai.
 - Year of commencement: 2016-17
 - Objective: 1.To study the natural environmental parameters of fairy shrimps.
2. To attempt mass-scale rearing to get year-round supply of fairy shrimps.
8. **AQ.CUL 12:** Culture of *Labeo rohita* fry in biofloc system.
- Principal Investigator : R. M. Tibile
 - Co-Investigators: Dr. A.S. Pawase, Dr. B.R.Chavan, Dr. D.I. Pathan, R. M. Tibile, Mrs. S.S. Wasave, Krupesh S Sawant and Dr. R. Pai
 - Year of commencement: 2016-17
 - Objective: 1.To evaluate effect of different levels of suspended solids on survival and growth of rohu, *Labeo rohita* fry in biofloc system.
2. To observe the growth and survival of *Labeo rohita* fry at different stocking densities in biofloc system.
9. **AQ.CUL 10:** Investigation on carrier status of *Crassostrea madrasensis* of Ratnagiri coast with respect to molluscan pathogens. (On- going project)
- Principal Investigator : Dr. G. S Ghode
 - Co-Investigators: Dr. R. Pai, Dr. A.S. Pawase, Dr. B.R.Chavan, Dr. D.I. Pathan, R. M. Tibile, Mrs. S.S. Wasave and Krupesh S Sawant
 - Year of commencement: 2016-22

- **Objective:** To investigate the presence of *Perkinsus olseni* and *Bucephalopsis haimeanus* in *Crassostrea madrasensis* of Ratnagir coast.

10. AQ.CUL 11: Assessment of natural metazoan parasites encountered in some commercially important marine species.

- Principal Investigator : Dr. A.S. Pawase
- Co-Investigators: Krupesh S Sawant, Mrs. S.S. Wasave, R. M. Tibile, Dr. D.I. Pathan, and Dr. R. Pai
- Year of commencement: 2016
-

11. AQ. CUL. 15 Studies on nursery rearing of tilapia in biofloc system

- Principal Investigator : S. S. Wasave
- Co-Investigators: Dr. S. D. Naik, Dr. A. S. Pawase, Dr. B. R. Chavan, Dr. S. J. Meshram, Dr. G. S. Ghode, Dr. R. M. Tibile and Dr. V. R. Bhatkar
- Year of commencement: 2021-22
- **Objective:** 1. To study the growth and survival of tilapia fry at different stocking densities in biofloc system during nursery phase
-

b. Completed Externally Funded Projects:

Project 1: Pilot scale demonstration on seed production of *Macrobrachium rosenbergii* using artificial seawater

Objectives:

1. To standardize different formulae available for the preparation of artificial seawater for the specific locality
2. To study optimum utilization of artificial seawater
3. To assess the performance of the formula for commercial seed production
4. To assess the performance seed produced in the artificial seawater
5. To develop standardized technology package for the establishment of hatchery in inland areas of the Maharashtra state

Name of PI/ Co-PI: Dr. Hukam Singh Dhaker, Dr. Gajanan S. Ghode

Sponsoring Agency: Ragiv Gandhi Science and Technology Commission, Mumbai

Duration: 2009-2012

Total Outlay: 18.77 Lakhs



Project 2: NAIP (Comp – 4)

Title: Study of the status and nature of variability in freshwater bivalves in the Western Ghats and identification of species with commercial value

Objective:

To study the distribution and status of indigenous freshwater bivalves traditionally known to have value as food and as source of product of commercial importance and resolve the taxonomic ambiguities in these species



Project 3 : Development of Economical Feed with good FCR.

Project 4: Refinement of Pearl culture Technology

Project 5: Ecological monitoring of the Arabian sea near Jaigad, Dist: Ratnagiri, Maharashtra with reference to JSW (Energy) power plant.

Project 6: Mussel Culture

Project 7: Survey of Potential sites for mussel and oyster culture along the coast of District Sindhudurga, Maharashtra State, India.

Project 8: Study on the status and nature of variability in freshwater bivalves in the Western Ghats and identification species with commercial value

Project 9: Mussel Mariculture

Project 10: Preliminary Assessment of the temperature tolerance limits of selected fishes and shellfishes of Jaitapur Coast around NPP Site –

Project 11 : Establishment of Circular hatchery-

Project 12: National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) Phase-I

Objectives:

- To survey the incidence of occurrence and distribution of diseases in aquatic animals of freshwater, brackish water and marine ecosystems in the state of Maharashtra.
- To rapidly detect new and exotic infectious diseases in aquatic animals in the State.
- To improve the collection of information on the disease aetiological data with reference to biotic and abiotic factors responsible for disease outbreak.
- To monitor health status of commercially important aquatic animals of aquaculture importance in targeted districts.

- To collect information on ITKs in health management of aquatic animals by farmers.
- To implement a national information management system for aquatic animal diseases of national concern.
- To improve reporting requirements to World Organisation for Animal Health (OIE) and regional Quarterly Aquatic Animal Disease reporting System and enhance compliance to OIE standards.

Name of PI: Dr. Gajanan S. Ghode

Dr. Dabir I. Pathan

Dr. Anil S. Pawase

Dr. Milind S. Sawant

Sponsoring Agency: National Bureau of Fish Genetic Resources, Lucknow

Duration: 2014-14 to 2019 and 2019 till date

Total Outlay: Rs. 73.63 lakhs

c. REVOLVING FUND PROJECTS:

COF/AQ CUL/Rev.F. 01 Rearing of costly ornamental fishes

Principal Investigator: Dr. S. D. Naik

Co-Investigators: Dr. A.S. Pawase
Dr. B. R. Chavan
Dr. S.J. Meshram
Dr. G.S. Ghode
Dr. R.M. Tibile
Dr. S. S. Wasave
Smt. V.R. Bhatkar
Smt. A.N. Sawant

Year of Commencement: 2009

1. Year wise expenditure and revenue

Year	Opening balance (Rs.)	Receipt (Rs.)	Expenditure (Rs.)	Grant allotted to other station (Rs.)	Closing balance (Rs.)
2008-09	0	0	93,525	0	10,475
2009-10	10,475	15,000	0	0	29,475
2010-11	29,475	45,300	24,980	0	49,795
2011-12	49,795	38,200	25,000	0	62,995
2012-13	62,995	40,200	0	0	1,03,195
2013-14	1,03,195	41,130	24,590	0	1,19,735
2014-15	1,19,735	68,413	0	0	1,88,148
2015-16	1,88,148	78,700	24,900	0	2,41,948
2016-17	2,41,948	38,050	49,785	0	2,30,213
2017-18	2,30,213	40,748	0	0	2,70,961
2018-19	2,70,961	33,540	15,655	0	2,88,846
2019-20	2,88,846	1,06,301	38,045	0	3,57,102

2020-21	3,57,102	7,220	1,424	0	3,62,898
2021-22	3,62,898	1,16,806	1,24,000	0	3,55,704
2022-23	3,55,704	26,500	22,831	0	3,59,373

E. Ongoing Research Projects/Programmes/Schemes:

a. Institutional projects

1. AQ.CUL 14: Induced spawning and larval rearing of *Perna viridis* under laboratory conditions.

- Principal Investigator : V. R. Bhatkar
- Co-Investigators: Dr. S. D. Naik, Dr. A. S. Pawase, Dr. M. S. Sawant, Dr. B. R. Chavan, Dr. S. J. Meshram, Dr. G.S. Ghode and Dr. R. M. Tibile.
- Year of commencement: 2017

b. Externally Funded Ongoing Projects:

1. Title: National Surveillance Programme for Aquatic Animal Diseases

(NSPAAD)

Objectives:

- To survey the incidence of occurrence and distribution of diseases in aquatic animals of freshwater, brackish water and marine ecosystems in the state of Maharashtra.
- To rapidly detect new and exotic infectious diseases in aquatic animals in the State.
- To improve the collection of information on the disease aetiological data with reference to biotic and abiotic factors responsible for disease outbreak.
- To monitor health status of commercially important aquatic animals of aquaculture importance in targeted districts.
- To collect information on ITKs in health management of aquatic animals by farmers.
- To implement a national information management system for aquatic animal diseases of national concern.
- To improve reporting requirements to World Organisation for Animal Health (OIE) and regional Quarterly Aquatic Animal Disease reporting System and enhance compliance to OIE standards.

Name of PI: Dr. Gajanan S. Ghode

Dr. Dabir I. Pathan

Dr. Anil S. Pawase

Dr. Milind S. Sawant

Sponsoring Agency: National Bureau of Fish Genetic Resources, Lucknow

Duration: 2014-14 to 2019 and 2019 till date

Total Outlay: Rs. 73.63 lakhs

2. Title: Demonstration of pond-based biofloc technology for seed rearing of rohu

Objective:

To demonstrate pond-based biofloc technology for seed rearing of rohu to end users

Name of PI: Dr. Raju M. Tibile

Name of Co-PI: Dr. S.D. Naik, Professor and Head; Dr. A.S. Pawase, Professor (CAS); Dr. G.S. Ghode, Associate Professor (CAS); Dr. B.M. Yadav, Associate Professor (CAS)

Sponsoring Agency: Rajiv Gandhi Science and Technology Commission (RGSTC), Mumbai

Duration: Three years from October, 2022

Total Outlay: Rs. 47. 81 lakh

- 3. Title:** NAHEP-IDP Project: Institutional Development for Enhancing learning outcome, Academic Diversity, entrepreneurship and employability: As Team member.
- 4. Title:** Research and Development -cum-demonstration of integrated agriculture-aquaculture for food security and improve the livelihood of schedule caste people of Konkan of Maharashtra: As PI.

F. Repository of abstracts of the theses: Provide here the years wise details of the abstract of the theses/projects approved by the Department/Section for Bachelor, Masters and Doctoral theses in following format

Studies on penaeid seed availability in relation to certain environmental parameter at the Shirgaon creek off Ratnagiri

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. S.G. Mane

Registration No.: 4

Year of thesis submission: 1998

Name of the research guide: Dr. A.M. Ranade

Designation: Head of the Department

The study was carried out to find out the relationship if any, between the environmental characteristics such as temperature, salinity, pH and dissolved oxygen and *penaeid* prawn seed availability, at the creek near Ratnagiri. Fortnightly collections were made at three localities, namely the Shirgaon, the Kasarveli and the Zadgaon. Studies were carried out for eight months covering the period from August 1997 to march 1998.

During the period under study it was found that the average temperature was 32.44 °C. The average salinity was 25.73 ppt. the average pH was 7.69 ppt and the average dissolved oxygen contents were 6.12 mg/l. Three penaeid prawn species were recorded namely, *Peneaus merguensis*, *Metapeneaus monoceros* and *Metapeneaus dobsoni*. Among these three species *P. merguensis* was found to be the dominant species, next to which was *M. monoceros* and lastly was *M. dobsoni*. Among the stations, Zadgaon station was found to be the richest station as regards to the penaeid prawn seed availability, followed by Kasarvelli station and the last was the Shirgaon station. The best period of seed availability was November 1997, December 1997, January 1998, February 1998.

It was also found that the temperature and salinity togetherly have the greatest influence on

the seed availability of the *P. merguensis* prawn but not on other two species. The studies were thus indicative of determining the best period of *P. merguensis* seed collections at the localities Zadgaon, Kasarveli and Shirgaon at the Ratnagiri in Maharashtra.

Studies on the Green mussel *Perna viridis* L. of the Mirya creek in Ratnagiri

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. H.B. Dhamagaye

Registration No.: 7

Year of thesis submission: 2000

Name of the research guide: Dr. A.M. Ranade **Designation:** Head of the Department

Investigations were carried out on resources and distribution, ecology and biology of the mussel species *Perna viridis* found along the coast of Ratnagiri. Sub-regional distribution survey along the coast showed that this species occurs in two creek namely, Mirya and Kalbadevi creek. The hydrographic features on Mirya creek showed the temperature in the range of 26 to 30.5 °C, salinity between eight and 36 ppt, pH around 7.5 to 8.57 and dissolved oxygen varied from 4.8 to 7.2 mg/L.

In morphometric studies on *P. viridis* with length, breadth, thickness, total weight and meat weight as factors, it was seen that this mussel does not follow the conventional relationship and that the growth is allometric. Allometric relationship in all the combinations showed that these all factors are significantly related to each other. The male : female ratio was found as 1: 0.62.

Observations on the percentage edibility and condition index revealed that the values were high from April to May 1998 and November 1998 to March 1999 and low from June to October 1998. In the growth studies, an inverse proportion was found to exist between the growth rate and the age. These mussels showed polymodal population with overlapping modes. Smaller mussel was 8.07 mm length and the oldest was 140 mm as computed from Von Bertalanffy growth equation. The growth was fast in the first year, diminished in the second and the years that followed.

The proximate composition analysis showed considerable seasonal variations in the different chemical constituents. Moisture content was high when the mussels were in spent condition during monsoon months and was low during the other periods of the year. Protein and fat values were found to be high during the gonadal ripe conditions and low during the resting phase. The high values of ash content coincided with the high value of protein and lipid and vice versa.

**Effect of culture media on embryonic development of the freshwater prawn
Macrobrachium rosenbergii (De Man)**

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. N.C. Nikam

Registration No.: 9

Year of thesis submission: 1999

Name of the research guide: Dr. H.T. Dhaker

Designation: Associate Professor

The study was undertaken to classify embryonic stages and to find out suitable media and salinity for the *in vitro* embryo culture of *Macrobrachium rosenbergii*.

During the present study, identification key was formulated for classification of embryonic stages. The effect of different media on embryonic development was tested and media E (Common salt – 420 g, KCl – 10 g, CaCl₂.2H₂O – 18 g, MgCl₂.6H₂O – 80 g, Na₂SO₄ – 65 g, NaHCO₃ – 3.4 g, KBr – 1.6 g and EDTA – 0.04 g in 10 litre freshwater to obtain 57 ppt salinity) was found to be better than other media for the *in vitro* embryo culture of *Macrobrachium rosenbergii*.

The effect of various salinities viz. 0, 2, 4, 6, 8 and 10 ppt was studied. The salinity of 2 ppt was found to be better than other salinities for *in vitro* embryo culture of *Macrobrachium rosenbergii*.

**Studies on some aspect of reproductive biology of female Banana shrimp,
Penaeus merguensis from Ratnagiri coast, India.**

Degree: M.F.sc.	Subject: Aquaculture
Name of the Student: Miss. Romisa Gull	Registration No.: 11
Year of thesis submission: 1999	
Name of the research guide: Dr. V.P. Joshi	Designation: Associate Professor

In the present investigation the morphology and histology of the ovary and the biochemical changes in the ovary and hepatopancreas during different stages of maturation in female, banana shrimp, *Penaeus merguensis* were studied.

Based on the morphological characters of ovary, the females were typified into five maturity stages namely stage one (immature), stage two (early maturing), stage three (late maturing), stage four (mature) and stage five (spent). The Gonado somatic index (GSI) increased from stage one to stage four, conversely the hepato somatic index (HSI) decreased from stage two to stage four of maturation. The complete process of oogenesis in the shrimp was studied. The ovarian protein and lipid values increased from first to four maturation stages, while both these values suddenly declined in fifth stage. Conversely the hepatopancreas protein and lipid values were highest during second stage of maturation and then decreased in third and fourth maturation stage.

The mobilization of protein and lipid occurs from the hepatopancreas to the ovary during maturation in *Penaeus merguensis* females.

Preliminary experimental studies on pearl culture in freshwater mussels

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. R.R. Sakpal	Registration No.: 12
Year of thesis submission: 1999	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The study was carried out to identify the collected freshwater mussels, to standardize the technique of the insertion of nucleus into the freshwater mussels and

to study post-operative care for the production of freshwater pearls. Present study was represented by three species of freshwater mussels which can be identified with the help of formulated key.

The different methods tested for implantation of nucleus were wrapping method (WM), nucleus shell mantle (NSM), nucleus shell mantle with graft (NSMG), nucleus insertion in pouch (NIP), nucleus insertion in pouch with graft (NIPG) and nucleus insertion with graft in gonad (NIGG).

Circular movement of water in suspension was found to be more suitable for the rearing of implanted mussels and growth of nacreous layer. The firm attachment of the nucleus was observed in *L. marginalis* and *L. corrianus*. Using wrapping method (WM), nucleus shell mantle (NSM) and nucleus shell mantle with graft (NSMG), rejection of nucleus was not observed in the 180 days rearing period with 60, 70 and 70 % survival respectively. Rejection of nucleus was not observed in 180 days in multiple implantations. Water quality was monitored through out the study.

Wrapping method (WM), nucleus shell mantle (NSM) and nucleus shell mantle with graft (NSMG) were found to be the best methods of production of pearl in freshwater mussels.

Effect of different probiotics on the growth of *Macrobrachium rosenbergii* (de Man) post-larvae

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. A.N. Shinde

Registration No.: 13

Year of thesis submission: 1999

Name of the research guide: Dr. V.P.

Designation: Associate Professor

Joshi

The first experiment was carried out to standardise the optimal dose of animal and plant protein sources required in the diet of post-larvae of *Macrobrachium rosenbergii* for rearing period of 30 days. The feed ingredients viz. groundnut oil cake, fish meal, rice bran and wheat bran were used to formulate a control diet (diet A) containing 40 % crude protein level. Other diets were formulated by deleting 25%, 50%, 75% and 100% fish meal and replacing the same with 25% (diet B), 50% (diet C), 75% (diet D) and 100% (diet E) quantity of soybean meal. The diet C showed significantly ($P < 0.05$) higher growth in terms of weight gain. In the second experiment, different probiotics viz. P-1, P-2, P-3 and P-4 were incorporated in the diet C used in the first experiment. The probiotics P-3 incorporated in the diet C showed significantly ($P < 0.05$) better growth performance than other diets. In the third experiment, probiotics P-3 used for second experiment was incorporated in different doses viz. 50, 75, 100, 125 and 150 mg per 100 g of feed. The results showed significantly ($P < 0.05$) higher growth performance of the post larvae fed Probiotic P-3 incorporated at the rate of 125mg/100g of feed than other treatments.

The study concluded that Probiotic P-3 incorporated in the diet C at the rate of 125mg/100g of feed (2.5×10^8 cfu/100 g of feed) resulted in best growth performance of *M. rosenbergii* post-larvae.

Experimental studies on maturation, spawning and larval development of edible oyster, *Crassostrea gryphoides*, (Scholtheim)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. R.M. Tibile
Year of thesis submission: 1999
Name of the research guide: Dr. H.T.
Dhaker

Registration No.: 16

Designation: Associate Professor

In the present investigation, the effects of different diets and salinity on maturation of *Crassostrea gryphoides* were observed. In the first experiment an attempt was made to find out the effects of different diets viz. mixed phytoplankton (diet 1), soya flour (diet 2) and soya flour + mixed phytoplankton (diet 3) on maturation of oysters. The oysters fed with diet 1 and diet 3 showed significantly higher number of oysters in maturing and ripe phases.

In the second experiment, the effect of salinity on maturation of oysters was evaluated. Four salinity media viz. 35, 30, 25 and 20 g.l⁻¹ were tested. The results revealed non significant effect of tested salinities on maturation of oysters. However, higher percentage of oyster in ripe phase were observed at salinity 35 g.l⁻¹.

The growth and cellular densities of marine microalga *Isochrysis* spp. were studied by using four nutrient media viz. control (NaNO₃ – 20 ppm, KH₂PO₄ – 2.0 ppm, FeSO₄.7H₂O - 1.2 ppm, Na₂SiO₃ – 4.0 ppm and EDTA – 1.2 ppm); A (Urea 10 ppm, KH₂PO₄ – 2.0 ppm, FeSO₄.7H₂O - 1.2 ppm, Na₂SiO₃ – 4.0 ppm and EDTA – 1.2 ppm); B (Suphala (20:20:20), NaNO₃ – 20 ppm, KH₂PO₄ – 2.0 ppm, FeSO₄.7H₂O - 1.2 ppm, Na₂SiO₃ – 4.0 ppm and EDTA – 1.2 ppm) and C (Urea 10 ppm, Suphala (20:20:20), FeSO₄.7H₂O - 1.2 ppm, Na₂SiO₃ – 4.0 ppm and EDTA – 1.2 ppm). The nutrient media control, A and B yielded significantly higher cellular densities and growth velocities than nutrient medium C. nutrient medium A was found to be cheaper than medium B and control medium.

C. gryphoides were induced to spawn by thermal stimulation technique and the larval developmental stages were observed as: straight hinge (70 x 62.5 µm), early umbo (96.25 x 87.5 µm), late umbo (215 x 152.5 µm), eyed stage (290 x 222.5 µm), pediveliger (308.25 x 254.17 µm) and spat (415.5 x 360.0 µm). These larval stages were observed at 20 h post spawning on 5th, 11th, 15th, 19th and 21st day, respectively. Spat settlement percentage was found to be 1.8 per cent.

**Studies on developing a simplified method for cyst production of brine shrimp,
*Artemia***

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. V.R. Vartak

Registration No.: 17

Year of thesis submission: 1999

Name of the research guide: Dr. V.P.

Designation: Associate Professor

Joshi

Experiments were carried out to develop simplified method for the cyst production of brine shrimp *Artemia*. The first experiment was carried out to find out effect of different feeds viz. *Tetraselmis*, *Chaetoceros*, *Spirulina*, Baker's yeast, rice bran, wheat bran, ragi powder (*Eleusine coracana* G- Dapoli 1), rice powder, fish meal, soyabean meal, groundnut oil cake and wheat flour on growth, maturation and cyst yield of *Artemia*. Among all the feeds, ragi powder led to the best growth, induced oviparity and yielded highest number of cysts in 15 days period. In the second experiment, cyst production was tested in the water of salinity ranged from 90 to 210 ppt. The results revealed an optimum salinity of 130 ppt for growth and cyst production. Per day cyst production of 1.65 g / 250 l of water was observed when *Artemia* were reared in 130 ppt salinity water and fed with appropriate dose of ragi

powder suspension.

Effect of certain synthetic hormones on the larval development, growth and maturation of *Betta splendens*

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. A.D. Adsul	Registration No.: 18
Year of thesis submission: 2000	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

Effect of certain synthetic hormones on growth and maturation of *Betta splendens* were studied. In the first experiment 30 days old fry were fed diet containing different hormones viz. Testosterone propionate, 3 mg/ kg; 17 α -Methyltestosterone, 1 mg/kg; 19-Norethisterone, 20 mg/ kg; Thyroxine, 5 mg/ kg. The basal diet without hormone served as control. The observations showed better growth in terms of length gain, weight gain and specific growth rate using testosterone propionate and 17 α -Methyltestosterone as compared to other hormones. In the second experiment, effect of various doses of Testosterone propionate (1, 2, 3, 4 and 5 mg/ kg of diet) and 17 α -Methyltestosterone (0.6, 0.8, 1.0, 1.2 and 1.4 mg/ kg of diet) on growth of 90 days old *B. splendens* was studied. Maximum length gain for Testosterone propionate was observed at 3.0 mg/ kg for male and 2.0 mg/ kg and 5.0 mg/ kg for female fishes. Maximum weight gain was observed at a dose of 2.0 mg/ kg for both the sexes. In case of 17 α -Methyltestosterone maximum length gain was observed at a dose of 1.0 mg/ kg for both the sexes. The maximum weight gain for male fishes was observed at a dose of 0.8 mg/ kg and for female fishes at 1.4 mg/ kg of diet.

In the third experiment, effect of various doses of testosterone propionate (1, 2, 3, 4 and 5 mg/ kg diet), 17 α -Methyltestosterone (0.6, 0.8, 1.0, 1.2 and 1.4 mg/ kg diet), 19- norethisterone (10, 15, 20, 25 and 30 mg/ kg diet) and thyroxine (3, 4, 5, 6 and 7 mg/ kg diet) on gonadosomatic index (GSI) of *B. splendens* were studied. The maximum GSI with testosterone propionate for male and female were recorded at doses of 2 mg/ kg and 1 mg/ kg of diet, respectively. Dietary inclusion of 17 α -Methyltestosterone at the rate of 0.6 mg/ kg showed maximum GSI in male and female fishes with respect to 19- noethisterone maximum GSI was recorded at 25 mg/ kg diet for male and female fishes at 20 mg/ kg diet. Dietary inclusion of thyroxine at the rate of 7 mg/ kg diet for male and 4 mg/ kg diet for female showed maximum GSI.

Larvae culture of freshwater prawn *Macrobrachium rosenbergii* (de Man) in different formulation of artificial sea water

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.W. Belsare	Registration No.: 23
Year of thesis submission: 2001	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

An experiment was undertaken to study the efficiency of different formulations of artificial sea water for larval development of freshwater prawn *Macrobrachium rosenbergii*. The three different artificial seawater media viz. Medium I common salt - 42.00 g, KCl - 1.00 g, CaCl₂2H₂O - 1.80 g, MgCl₂6H₂O -

8.00 g, Na₂SO₄- 6.50 g, NaHCO₃ - 0.34, KBr - 0.16 g and EDTA - 0.004 g, (dissolved in 1 liter freshwater to obtain 57 ppt salinity, used for preparation of 12 ppt seawater), medium II common salt, 23.51 g; Mg SO₄.7 H₂O, 5.74 g; MgCl₂6H₂O, 4.55 g; CaCl₂2H₂O, 1.99 g; and KCL, 10 g, dissolved in 1 liter freshwater to obtained salinity of 30 ppt, used to prepare 12 ppt seawater and medium III (common salt - 9.40 g, KCl - 0.26 g, CaCl₂2H₂O - 0.44 g, MgCl₂6H₂O - 1.900 g, Na₂SO₄- 1.56 g, NaHCO₃ - 0.08, KBr - 0.04 g and H₃BO₃ - 0.001g, dissolved in 1.0 liter freshwater to obtain 12 ppt salinity) were used. The larval survival of 21.6 %, 0% and 12.11% was observed in medium I, II and III respectively. The results of present study indicated use of Medium I and III for larval rearing of *Macrobrachium rosenbergii*.

Supplementation of amino acids in practical diet for post-larvae of *Macrobrachium rosenbergii*.

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. P.V. Kulkarni	Registration No.: 28
Year of thesis submission: 2001	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The experiments were undertaken to evaluate effect of certain amino acids on growth and survival of post-larvae of *Macrobrachium rosenbergii*. The role of crystalline amino acids such as L-histidine, L-lysine, L-methionine, L-cystine, L-tyrosine and L-valine on growth and survival of post larvae of *Macrobrachium rosenbergii* was evaluated. The growth was measured in terms of gain in weight and length and specific growth rate. The effect on food conversion ratio (FCR) and protein efficiency ratio (PER) were also studied. The amino acid L-tyrosine gave better growth i.e. maximum specific growth rate, maximum average length gain, maximum average weight gain and survival as compared to other amino acids. In other experiment L-tyrosine gave minimum FCR (1.23) and maximum PER (2.05) as compared to other diets. The different doses such as 0, 2, 4 and 6 g/100 of amino acid in diet were tested and doses of 4 g/ 100 g gave better growth and survival. The test diet with L-tyrosine recorded maximum length gain (1.75 cm), specific growth rate (7.46) and survival (83.33%) as compared to other and control diets.

The study indicated incorporation of amino acid L-tyrosine (4 g/100g) is essential for better growth and survival of post-larvae of *Macrobrachium rosenbergii*.

Experimental studies on post larval rearing in cages of the giant freshwater prawn *Macrobrachium rosenbergii* (De Man) in Kharland ponds

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. A.G. Naik	Registration No.: 30
Year of thesis submission: 2001	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The experiments were undertaken to assess the effects of stocking densities and types of cages on growth, survival and production of post-larvae of *Macrobrachium rosenbergii* in cages installed in kharland ponds. In the first experiment, post-larvae were grown at different densities viz. 150, 300 and 600 PL/m². Significantly (P<0.05) higher growth in terms of length and weight gain, specific growth rate and survival were observed for a density of 150 and 300 PL/m². However, significantly (P<0.05) higher production was recorded for density of 300

PL/m². The second experiment was carried out to test the suitability of different types of cages viz. nylon, bamboo and galvanized iron cages for culture of post-larvae of *M. rosenbergii* for 90 days. The galvanized iron cages deteriorated within 15 days. Among the tested types of cage, nylon cages were found to be suitable for culture as significantly ($P < 0.05$) higher growth, survival and production were recorded.

Growth and survival of post-larvae of *Macrobrachium rosenbergii* (De Man) fed on artificial diet supplemented with some hormones

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. M.M. Shinde	Registration No.: 32
Year of thesis submission: 2001	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The present study was carried out to investigate the effect of different hormones on survival, food conversion efficiency (FCE), specific growth rate (SGR) and protein efficiency ratio (PER) of post larvae of *Macrobrachium rosenbergii*. Experimental pelleted diet was prepared by using locally available ingredients viz. rice bran, wheat flour, fish meal and ground nut oil cake containing 35% protein and it was treated as control diet.

The hormones viz human chorionic gonadotropin (HCG), 17 α -methyltestosterone and testosterone were administered @ 3 mg/ kg in artificial diet. The significant difference ($P < 0.05$) was observed in length gain, weight gain, specific growth rate and survival in 17 α -methyltestosterone incorporated diet as compared to human chorionic gonadotropin, testosterone and control. Better FCE and PER were observed with 17 α -methyltestosterone incorporated diet. Significantly higher length gain, weight gain and specific growth rate was observed with 2 mg/ kg while studying the different doses of 17 α -methyltestosterone, compared to 1, 3, 4 and 5 mg hormone/ kg of diet.

Therefore, from the present study it has been clearly indicated that synthetic steroid 17 α -methyltestosterone enhances growth, survival, FCE and PER of post larvae of *M. rosenbergii* and could hopefully be stocked in culture of *M. rosenbergii* for better survival and production. This administered steroid gets rapidly metabolized and eliminated from the body of the organism, so safe for human consumption.

Response of Tilapia fingerlings to Surimi waste water

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.M. Wasave	Registration No.: 33
Year of thesis submission: 2001	
Name of the research guide: Dr. G.N. Kulkarni	Designation: Associate Professor

The present study was carried out to investigate the characteristics of surimi waste water and its effects on fingerlings of Tilapia, *O. mossambicus*. The samples of surimi waste water were collected from the discharge outlet of local surimi processing plant and analysed for physico-chemical parameters. During analysis this effluent was found deficient in dissolved oxygen accompanied by very high values of BOD, the values of pH, alkalinity, hardness and nitrite were observed in normal range, but high levels of ammonia, nitrate and chlorine were prominent in the waste water sample.

Low concentrations (5 to 10 %) of surimi waste water gave 100% survival of tilapia fingerlings in 96 hrs period acute response study while this trend showed that as the concentration of surimi waste water increased the survival of the fingerlings of tilapia decreased. The lower concentration of surimi waste water also no growth of tilapia fingerlings was found. During the rearing experiment the application of the treatment methods as, aeration and filtration did not improve the survival. In the purification experiment, the algal growth was observed on 12th day in the 100% concentration of surimi waste water, with slight increase in dissolved oxygen content. Based on the observations from the present study it was concluded that the surimi waste water can not be used as direct medium even at lower concentrations.

Growth performance of carps in kharland pond located at Shirgaon, Ratnagiri

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.R. Yadav	Registration No.: 34
Year of thesis submission: 2001	
Name of the research guide: Dr. G.N. Kulkarni	Designation: Associate Professor

The study was conducted to test the suitability of rearing rohu, *Labeo rohita* spawn and fry and tolerance of common carp, *Cyprinus carpio* fry in different salinities through bifactorial experimental design in kharland pond condition. Rohu spawn showed decreased survival with increasing salinity and beyond 4 ppt salinity, no spawn survived after 48 hours. Attempts of rearing spawn of rohu showed higher mortality due to existing water condition in the kharland pond. The study indicated that rohu fry could be reared in the kharland pond upto 4 ppt salinity only for a period of ten days. The tolerance test of the common carp fry showed 100 per cent survival upto 10 ppt salinity followed by gradual decrease with increase in salinity. No survival was recorded beyond 12 ppt. Growth performances of common carp fry in freshwater and 5 ppt salinity showed more or less similar growth. In 12 ppt salinity, the growth showed drastic decline. Common carp showed marginally better growth when fed with the ragi incorporated feed compared to the traditional rice bran. The study showed possibility of rearing *Cyprinus carpio* fry in low saline ponds having salinity upto 5 ppt.

Supplementation of Biotin in practical diet of *Liza parsia* (Hamilton-Buchanan, 1822) fry

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. S. L. Chavan	Registration No.: 36
Year of thesis submission: 2002	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The effect of vitamin level of biotin viz. 0.4, 0.8, 1.6, 3.2 and 6.4 mg biotin /kg diet was studied on fry of *Liza parsia* for each level of biotin 90 days. The experiment was conducted in four replicates. The maximum length gain (292.80%), weight gain (2287.20%) and specific growth rate (3.525) were recorded at 3.2 mg biotin /kg (T₄) diet which survival (85%) at 1.6 mg biotin /kg (T₃) diet.

An experiment was conducted to evaluate the effect of different levels of

biotin on bioenergetic parameters for fry of *Liza parsia*. It was conducted in duplicate for 42 days. The maximum food conversion ratio, protein efficiency ratio, relative growth rate, conversion rate, gross growth efficiency, assimilation efficiency, assimilation, metabolism, digestibility energy, protein digestibility co-efficient, lipid digestibility co-efficient were observed at 3.2 mg biotin /kg diet (T₄). While maximum consumption / unit weight/ day at 0.8 mg biotin/ kg diet (T₂) and net gross efficiency at 6.4 mg biotin /kg diet (T₅). The proximate carcass composition showed better apparent protein retention at 3.2 mg biotin/ kg diet (T₄) and apparent lipid retention at 1.6 mg biotin /kg diet (T₃). The present study indicates the optimum level is 3.2 mg biotin /kg diet for fry of *L. parsia*.

The effect of supplemental L-Ascorbic Acid in practical diet for *Liza parsia* (Hamilton-Buchanan 1822) fry.

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. M.N. Narvekar	Registration No.: 38
Year of thesis submission: 2002	
Name of the research guide: Dr. A.M. Ranade	Designation: Head and Professor

Fry of *Liza parsia* were fed whole poultry egg based flakes diet supplemented with various levels viz. 30, 60, 120, 240 and 480 mg L-AA/ kg of diet. The two experiments were carried out. The first experiment was conducted in four replicates for 90 days. The maximum length gain, weight gain, specific growth rate and survival recorded was 297.92 %, 2351.22%, 3.55 and 90% respectively in diet T₅ (480 mg L-AA/ kg) diet and no significant difference was observed in diet T₄ (240 mg L-AA/ kg) and diet T₅.

Second experiment was conducted to evaluate the bioenergetic parameters such as FCR, PER, assimilation, metabolism, assimilation efficiency, gross growth weight/ day, conversion rate, protein digestibility co-efficient, lipid digestibility co-efficient, digestible energy, apparent protein digestibility and apparent lipid digestibility of *Liza parsia* at various levels viz. 30, 60, 120, 240 and 480 mg L-AA/ kg of practical diet for 42 days. The diet T₄ (240 mg L-AA/kg) showed better PER, assimilation efficiency, metabolism, protein digestibility co-efficient, lipid digestibility co-efficient and digestibility energy.

Results of this study indicated that 240-480 mg L-AA/kg diet is needed for the better growth and survival of fry of *Liza parsia*.

Effect of stocking density, salinity, and aerial exposure on survival of the clam, *Paphia malbarica*

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.V. Patil	Registration No.: 39
Year of thesis submission: 2002	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

Paphia malbarica was studied for determining optimum salinity tolerance range under laboratory condition at 0, 6, 12, 18, 24 and 30 ppt salinity. The maximum

survival (100%) was recorded at 24 ppt salinity and no survival was found in 0 ppt and 6 ppt salinity after 168 hrs. Salinity of 18 ppt to 30 ppt was found to be optimum for this clam.

P. malbarica was exposed to humid air for 78 hrs. After 54 hrs., 70% of clams showed gapping between shell valves and thereafter it increased. All the clams were died at 78 hrs.

P. malbarica burries itself by fanning sediment particles backwards with foot movement and simultaneously moving downwards into substratum with umbo. The maximum burrowing depth recorded was 4.1 cm and 5 cm for Kalbadevi and Mirya sediments respectively. All clams burrowed in Kalbadevi and Mirya sediments after 30 and 36 hrs. respectively.

P. malbarica were stocked at five stocking densities viz. 200, 400, 600, 800 and 1000 nos/ m² in pits (1 x 1 x 0.12 m) at Kalbadevi estuary. Initial average shell length and average initial total weight was 41.05 mm and 19.15 g respectively. The maximum shell length, total weight, meat weight and production was 45.35 mm, 24.73 g, 3.61 g and 382.66 g respectively at stocking density of 200 no/ m² after a period of six months under environmental condition. The optimum stocking rate was 200 no./ m² having survival rate of 52.75%. The available nitrogen of the sediment was decreasing while organic carbon increased with stocking density.

Studies on the cage culture of *Penaeus monodon*

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. S. I. Yusufzai

Registration No.: 41

Year of thesis submission: 2002

Name of the research guide: Dr. H.T. Dhaker

Designation: Associate Professor

The use of floating cages as nursery enclosures for shrimp post larvae were tested. Three stocking densities (100, 200 and 400/ m²) of *Penaeus monodon* post larvae (PL₂₀, total length= 12 mm, wet weight = 10 mg) were evaluated in 0.5 x 0.5 x 0.5 m floating nylon net cages. Post larvae stocked at 100 PL/ m² attained highest total length of 53.5 mm, wet weight of 928.7 mg and specific growth rate (SGR) of 15.10%/ day after 30 days with 78% survival. There was no significant difference (P>0.05) for total length gain, wet weight gain, specific growth rate and survival between stocking density of 100 and 200 PL/ m². Results indicated negative relationship with total length gain, wet weight gain, specific growth rate and survival to stocking density, but it was not significant (P>0.05).

The juveniles (total length = 53.23 mm, wet weight = 0.9170 g) thus obtained from the nursery phase were stocked in grow out floating nylon net cages (1 x 0.5 x 0.5 m) at 100 nos./ m². Final total length, wet weight and specific growth rate attained by juveniles after 60 days rearing was 86.03 mm, 5.0217 g and 2.83%/ day respectively with 84% survival. The average weight increase was found to be 0.068 g/ day and production was 421.8 g/m² for 60 days.

In another experiment, juveniles were stocked at 100 no/ m² in floating nylon net cages (0.5 x 0.5 x 0.5 m) to evaluate the effect of feeding frequency viz. 2, 3 and 4 times/ day. Juveniles fed 4 times/ day attained highest total length gain (40.04%), wet weight gain (294.80%), and SGR (4.58 %/ day) with 91.5% survival after 30 days, but no significant difference (P>0.05) was observed between feeding frequency of 3 and 4 times/ day. A direct relationship was found with total length gain, wet weight gain, specific growth rate and survival to feeding frequency, but it was not significant (P>0.05).

Effect of groundnut oil cake, mustard oil cake and soya cake in the practical diet of *Liza parsia* (Hamilton-Buchanan, 1822) fry

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. G.P. Sawant	Registration No.: 44
Year of thesis submission: 2002	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

Fry of mullet *Liza parsia* were fed with whole poultry egg based flakes diet (T₀) supplemented with various oil cakes viz. mustard oil cake (T₁), groundnut oil cake (T₂) and soya cake (T₃). The first experiment was conducted with five replicates for 90 days. The maximum length gain, weight gain, specific growth rate and survival recorded was 429.20%, 2140.377%, 3.45 and 86% respectively in diet T₁ (mustard oil cake) and found significant difference among the diets.

Second experiment was conducted to evaluate the bioenergetics parameters in fry of *Liza parsia*. The experiment was conducted in duplicate for 42 days. the diet T₁ (mustard oil cake incorporated diet) showed better FCR, PER, assimilation efficiency, metabolism, gross growth efficiency, relative growth rate, conversion ration, lipid digestibility co-efficient and digestibility energy for fry of *Liza parsia*.

The maximum apparent protein retention was found in diet T₃ (soya cake) and maximum lipid retention was in diet T₁ (mustard oil cake).

Based on these results, mustard oil cake can be used in feed for better growth and survival for fry of *Liza parsia*.

Effect of few selected anesthetics for the seed of *Liza parsia* (Hamilton-Buchanan, 1822)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. U.D. Sonawane	Registration No.: 45
Year of thesis submission: 2002	
Name of the research guide: Dr. G.N. Kulkarni	Designation: Associate Professor

The anaesthetic properties of clove oil and sodium bicarbonate were tested on the fry of gold spot mullet, *Liza parsia* obtained from the creeks and bays located in and around Ratnagiri. The effective concentration for both clove oil and sodium bicarbonate worked out to 80 and 4000 ppm respectively. The median lethal concentrations of clove oil and sodium bicarbonate were 446.68 and 22 387.21 ppm respectively. The clove oil was noted to be effective at 10 ppm for 24 hours long term exposure. Darkening of body colour was conspicuous in fry of *L. parsia* during anaesthesia. Oxygen consumption rate was noted to increase in the process of induction as compared to control (17.06), in both clove oil (46.75) and sodium bicarbonate (107.32) anaesthesia. Both the anaesthetics were estimated cost effective as compared to the synthetic MS-222.

Effect of Sulphide on the clams, *Paphia malbarica* (Chemnitz) and *Katelaysia opima* (Gmelin) of Kalbadevi Estuary, Ratnagiri.

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. M.M. Girkar	Registration No.: 47
Year of thesis submission: 2003	
Name of the research guide: Dr. G.N. Kulkarni	Designation: Associate Professor

The two spp of edible clams *Paphia malbarica* (Chemnitz) and *Katelaysia opima* (Gmelin) were stocked at five stocking densities viz. 50, 100, 200, 500 and 1000 nos./ m² in the pits (1x1x 0.25 m) dug in the tidal flat area of Kalbadevi estuary, Ratnagiri.

During seven months period, surface water temperature and salinity in the experimental pits varied from 27 to 31°C and 22 to 30 ppt respectively without any particular seasonal trend. The maximum pH value of 7.83 at 50 nos./ m² and minimum of 7.39 and 7.34 at 1000 nos./ m² were observed for *P. malbarica* and *K. opima* respectively, while dissolved oxygen fluctuated from 2 mg/L at stocking density of 1000 nos./ m² to the maximum of 5.62 mg/L at 100 nos./m² in *P. malbarica* and 5.36 mg/L at 50 nos./ m² to the lowest 2 mg/L at 1000 nos./m² stocking density. The water pH and dissolved oxygen showed marginal but gradual decrease with the increase of stocking density and also with the progress of the season. Dissolved sulphide increased with increase in stocking density ranging from 0.43 mg/L at stocking density 50 nos./ m² to the maximum 1.12 and 1.16 mg/L at stocking density of 1000 nos./ m² in case of *P. malbarica* and *K. opima* respectively.

Soil sulphide values fluctuated from minimum of 1.26 mg/L in both the species at 50 nos./m² and to the maximum of 2.86 and 2.91 mg/L at 1000 nos./m² in *P. malbarica* and *K. opima* respectively. The soil sulphide increased with increase in stocking density. The minimum soil pH was 7.57 and 7.44 at stocking density of 1000

nos./ m² in *P. malbarica* and *K. opima* respectively, while both species had maximum of 8.47 at 50 nos./ m². pH showed gradual decrease with increasing stocking density. Organic levels were lowest 0.23 and 0.27 (%) at the stocking density 50 nos./ m² while the peak values of 0.94 and 1.07 (%) occurred at 1000 nos./ m² in *P. malbarica* and *K. opima* respectively.

The optimum stocking density with reference to the sulphide level was at 50 nos./ m² with the survival rates of 69 and 65 (%) in *P. malbarica* and *K. opima* respectively.

96 h LC₅₀ of sulphide for *P. malbarica* and *K. opima* were 4.49 and 5.67 mg/L respectively. The oxygen consumption and filtration rates decreased in sulphide treated sets as compared to the control, in both the species of clams tested.

Some studies on rearing of juvenile (pony) sea horse *Hippocampus kuda* Bleeker, 1852

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. V.C. Autade	Registration No.: 48
Year of thesis submission: 2003	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The seahorse *Hippocampus kuda* comes under genus *Hippocampus* and family Syngnathidae. Morphometric and meristic study of *H. kuda* showed the variation in morphological characters such as snout length, postorbital distance, trunk rings and colour, it may be due to environmental factors. The monthly population variations were observed and found the maximum number in October and September at Mirya and Shirgaon creek of Ratnagiri coast respectively. During present study, the gestation period of male *H. kuda* was 21 days and produced 320 juveniles. Rearing of juveniles of *H. kuda* was conducted by using different live feed such as copepod nauplii, *Artemia* nauplii and mixed phytoplankton. Survival and growth was better in copepod nauplii as compared to *Artemia* nauplii and mixed phytoplankton. Feeding efficiency of early juveniles also increased by using the white colour culture vessels. Different stocking densities were used for rearing juveniles of *H. kuda* and found maximum growth and survival at 4 nos/ L stocking density.

Growth, survival and production of green mussel, *Perna viridis* L. cultivated by stake culture at Mirya, Ratnagiri

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Dhanunjaya Goud	Registration No.: 50
Year of thesis submission: 2003	
Name of the research guide: Dr. A.M. Ranade	Designation: Head and Professor

The green mussel, *P. viridis* was cultured by using stake culture method in inter-tidal waters of Mirya creek, Ratnagiri. Two types of substrates (nylon rope and plastic strip) were used for culturing the *P. viridis*. The mussels were seeded at density of 1.5 kg per meter of each ren. After eight months culture period, *P. viridis* showed the maximum growth rates in shell length, shell width, shell height, live weight, wet meat weight (WMW). Dry meat weight (DMW) and shell weight in ren of plastic strip substrate. Survival and production was also found better in plastic strip substrate in eight months and found significant difference (p<0.05) between two

substrates. During the culture period, water parameters reported to be within the permissible levels.

Three different seeding densities viz. 1, 1.5 and 2 kg per meter of each ren were tested for growing *P. viridis*. The different seeding densities showed inverse relationship with growth rates and survival and it was found to be significantly different ($P < 0.05$). The maximum production (15.11 kg/m) was obtained at density 2 kg per meter ren in eight months.

Different stitching materials viz., cotton and nylon threads were used for preparation of tube for culture of *P. viridis*. There was no significant difference ($P < 0.05$) between two stitching materials for the growth of *P. viridis*. The maximum survival and production was observed in cotton stitched tubes than nylon stitched tubes but it was not found statistically significant difference ($P > 0.05$).

Growth and survival of post-larvae of *Macrobrachium rosenbergii* fed with marine fish meat incorporated diet.

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. M.J. Gitte	Registration No.: 52
Year of thesis submission: 2003	
Name of the research guide: Dr. S.T. Indulkar	Designation: Associate Professor

The study was carried out to evaluate influence of the diets incorporated with various marine fish meat powder on growth and survival of post larvae of *M. rosenbergii*.

In the first experiment, five different diets were prepared by using meat powder of Ribbon fish (diet I), Dhoma (diet II), Pink perch (diet III), Catfish (diet IV) and Khawli (diet V). The diet incorporation with Pink perch meat powder resulted in better growth and survival of post larvae of *M. rosenbergii* during 30 days of nursery rearing.

In the second experiment, effect of diets containing varied levels of Pink perch meat powder (20%, 25%, 30%, 35% and 40%) on growth and survival was observed. The study revealed higher growth and survival with incorporation of Pink perch meat powder in the range of 25-30% diet in nursery rearing of *M. rosenbergii*.

Effect of some submerged macrophytes on water quality for aquaculture

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. S.S. Jamsendekar	Registration No.: 53
Year of thesis submission: 2003	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The effect of aquatic macrophytes such as *Vallisneria spiralis*, *Hydrilla verticillata*, *Cobomba caroliniana* and *Nomaphila stricta* on water quality in an aquarium system was evaluated. The specific conductivity, total dissolved solids, total hardness, free carbondioxide, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen and orthophosphate were decreased from water and pH, total alkalinity and dissolved oxygen were increased by these macrophytes. It was also found that *Vallisneria spiralis* was an efficient plant for maintaining the water quality in the aquatic system.

Vallisneria spiralis was planted at different intervals such as 2 cm, 4 cm, 6

cm and 8 cm. Maximum uptake of water parameters such as specific conductivity, total dissolved solids, total hardness, free carbon dioxide, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen and orthophosphate in 28 days was also found better at 4 cm distance with better growth of *Vallisneria* in 28 days. *Vallisneria spiralis* was planted at different biomass viz. 78 g, 156 g, 234 g, and 312 g in each aquarium and observed maximum uptake of ammonia, nitrate and nitrite in 28 days. The growth of *Vallisneria spiralis* was significantly increased when planted with 312 g biomass in aquarium.

Vallisneria was evaluated for nutrient removal potential and maintaining the water quality in aquarium stocked with fry of *Carassius auratus*. Ammonia, nitrate, nitrite were removed and improved the water quality in the aquarium system. Growth and survival of fry was 0.018 g and 69% respectively in 30 days without replacing water. The biomass of the plant was also increased due to growth of plants. This growth may be attributed due to supply of nutrients from the metabolic waste of the fish and feed.

The present study suggested the *Vallisneria spiralis* can be used to maintain the water quality in the aquarium system.

Growth, survival and production in raft cultivated green mussel *Perna viridis* L. at Kalbadevi estuary, Ratnagiri

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. G.M. Jakate

Registration No.: 54

Year of thesis submission: 2003

Name of the research guide: Dr. H.T.

Designation: Associate Professor

Dhaker

The green mussel, *P. viridis* was cultured by using floating raft (6.32 x 2.7 m) at Kalbadevi estuary, Ratnagiri. Two types of substrata (nylon rope and nylon strip) were used for growing the mussels. The mussel seeds were seeded at 1.67 kg/ m of each ren. After seven months of culture period, the mussels seeded on nylon rope showed maximum growth, survival and production. Survival and production of *P. viridis* showed significant ($P < 0.05$) difference between the different substrata in the raft culture. During culture period, growth was reduced after five months due to low salinity in monsoon months (July and August).

Five different seeding densities viz. 1.0, 1.33, 1.67, 2.0 and 2.33 kg/ m were used for raft culture of *P. viridis*. The seeding densities showed inverse relationship with growth rate of *P. viridis*. The maximum survival and production was obtained at seeding densities of 2.0 kg/ m each ren in seven months.

Different stitching materials viz. cotton and nylon threads were used for preparation of tubes of *P. viridis* in raft culture. There was no significant difference between growth, survival and production in two stitching materials ($P > 0.05$). However, slightly higher growth, survival and production were recorded on nylon thread stitching compared to cotton thread stitching. Economical analysis of raft culture of *P. viridis* showed feasibility for utilizing the estuarine areas of the Konkan coast.

Effect of some organic manures on productivity for kharland ponds, Ratnagiri.

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. P.A. Khandagale	Registration No.: 56
Year of thesis submission: 2003	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The effect of different organic manures viz. chicken, cattle dung, vermicompost and biogas slurry on the productivity of kharland pond soil was studied for a period of eight weeks. All the manures were applied at the basal rate of 5000 kg/ha. Highest level of water and soil nutrients and primary productivity was observed in the chicken manure treatment.

Different doses of chicken manure viz. 2000, 3000, 4000, 5000 and 6000 kg/ha were used for the standardization of dose. The values of available nitrogen and net primary productivity in 5000 and 6000 kg/ha dose of chicken manure were not significantly different.

Effect of salinity on the mineralisation of chicken manure was carried out during the present study. Different treatments of salinity viz. 0, 10, 20, 30 and 35 ppt were selected on the basis of salinity prevail in kharland pond during the whole year. It was observed that release of nutrients especially available nitrogen and phosphorous increased as salinity increased.

Field trials were conducted to evaluate the effect of chicken manure (5000 kg/ha) on the productivity of kharland pond. It revealed increase in productivity of kharland pond in terms of water and soil nutrients and also the primary productivity. The results of study also confirmed the results of experiments conducted under laboratory conditions.

Results of present study indicated that the application of chicken manure at the rate of 5000 kg/ha is useful to increase the productivity of kharland pond.

Utilization of waste product of Mango pulp industry for rearing of post-larvae of *Macrobrachium rosenbergii* (De Man, 1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.S. Belsare	Registration No.: 60
Year of thesis submission: 2004	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

Experiment I was conducted to study the effect of mango seed kernel incorporated diet on growth and survival of post-larvae of *M. rosenbergii*. The experiment was conducted in triplicate for 42 days. The post-larvae were fed with fish meal based control diet (T₀) and test diets. Test diets were prepared by replacing fish meal with mango seed kernel powder at 5 % (T₁), 10 % (T₂), 15 % (T₃), 20 % (T₄), 25 % (T₅) and 30 % (T₆) level. The maximum length gain (69.66 %), weight gain (286.34 %), specific growth rate (3.20 %) and survival (93.33 %) were recorded in post-larvae fed with diet T₁. There was no significant difference in length gain, specific growth rate and survival of the post larvae fed with diets T₀, T₁, T₂ and T₃ while there was no significant difference in weight gain of post larvae fed with diets T₀, T₁ and T₂.

Experiment II was carried out to evaluate the bioenergetic parameters in the post-larvae of *M. rosenbergii*. The experiment was conducted in duplicate for 10 days. The

post larvae fed with diet T₁ showed better food conversion ratio, protein efficiency ratio, assimilation, gross growth efficiency, net growth efficiency, relative growth rate, consumption/ unit weight/ day, conversion rate, protein digestibility co-efficient and lipid digestibility coefficient. Maximum metabolism was recorded in T₄ diet and maximum assimilation efficiency in T₃ diet. Maximum feed nutrient utilization was observed in diet T₁. There was no significant difference in post larvae fed with T₀ and T₁ diets for all the bioenergetic parameters except assimilation efficiency and relative growth rate.

The results of experiment I and experiment II revealed that mango seed kernel powder can be incorporated by replacing fish meal upto 5 % level for the better growth, survival and feed utilization of post-larvae of *M. rosenbergii*.

Experiment III was carried out to study the effect of mango peeling incorporated diet on growth and survival of post-larvae of *M. rosenbergii*. The experiment was conducted in triplicate for a period of 42 days. The post larvae were fed with fish meal based control diet (T₀) and test diets. Test diets were prepared by replacing fish meal with mango peeling powder at 5% (T₁), 10% (T₂), 15% (T₃), 20% (T₄), 25% (T₅) and 30% (T₆) level. The maximum values of length gain, weight gain, specific growth rate and survival were 48.66 %, 111.18 %, 1.76 % and 94.44 % respectively, in T₃ diet. Post larvae fed with diet T₃ were not significantly different from the post larvae fed with diet T₄ in length gain, weight gain and specific growth rate.

Experiment IV was conducted to evaluate the bioenergetic parameters in the post-larvae of *M. rosenbergii* for 10 days. The experiment was conducted in duplicate for 10 days. The post larvae fed with diet T₃ showed better food conversion ratio, protein efficiency ratio, assimilation, assimilation efficiency, gross growth efficiency, net growth efficiency, relative growth rate, consumption/ unit weight/ day, conversion rate, protein digestibility co-efficient and lipid digestibility co-efficient. Maximum value of metabolism was recorded in control diet (T₀). Thus, better feed nutrient utilization was found in diet T₃.

The present study revealed that mango peeling powder can be incorporated by replacing fish meal upto 15 % level for the better growth, survival and enhanced feed utilization of post-larvae of *M. rosenbergii*.

Supplementation of some microorganisms in the practical diet of post-larvae of *Macrobrachium rosenbergii* (De Man,1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. V.V. Joshi	Registration No.: 64
Year of thesis submission: 2004	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

Experiment I was conducted to study effect of formulated diets incorporated with microorganisms *Lactobacillus sporogenes* on growth, survival and feed utilization of post larvae of *Macrobrachium rosenbergii* for 42 days. Experiment was conducted in four replicates. control diet was supplemented with *L. sporogenes* at 15 x 10⁶, 45 x 10⁶, 60 x 10⁶, 75 x 10⁶ cfu/ 100g for T₁, T₂, T₃, T₄ and T₅ respectively. Maximum length gain (52.43% cfu/100g), weight gain (290.90%) and SGR (3.241%) were recorded in T₅ (75 x 100g of *L. sporogenes*).

Experiment II was conducted to evaluate the effect of *L. sporogenes* incorporated diets on bioenergetic parameters of post larvae of *M. rosenbergii*. It was conducted in duplicate for 10 days. The maximum relative growth rate (0.12)

conversion ratio rate (0.0379), assimilation efficiency (97.40%), assimilation (0.0565g), protein digestibility coefficient (75%), consumption/unit weight/day (0.0349), lipid digestibility coefficient (53.20%) were observed in post larvae fed with diet T₅ (75 x 10⁶ cfu/ 100g).

Experiment III was conducted to study effect of *L. acidophilus* incorporated diet on growth, survival and feed utilization of post larvae of *M. rosenbergii* for 42 days. The experiment was conducted in four replicates. Post larvae were fed with diets supplemented with *L. acidophilus* at 15 x 10⁶, 30 x 10⁶, 45 x 10⁶, 60 x 10⁶, 75 x 10⁶ cfu/ 100g in T₁, T₂, T₃, T₄ and T₅ respectively. Maximum length gain (46.85%), weight gain (195%), SGR (2.569%) and survival (85.92%) were observed in treatment T₃ (45 x 10⁶ cfu/100g).

Experiment IV was conducted to evaluate the effect of *L. acidophilus* incorporated diets on bioenergetic parameters of post larvae and it was observed that the post larvae of *M. rosenbergii* fed with diet (45 x 10⁶ cfu/100g of *L. acidophilus*) was good.

The present study showed that diet incorporated with *L. sporogenes* (75 x 10⁶ cfu/100g) and *L. acidophilus* (45 x 10⁶ cfu/100g) was found suitable to enhance feed utilization of post larvae of *M. rosenbergii*.

Growth and survival of post-larvae of *Macrobrachium rosenbergii* (De Man, 1879) fed with practical diet containing some enzymes

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. D.W. Patil

Registration No.: 67

Year of thesis submission: 2004

Name of the research guide: Dr. H.T. Dhaker **Designation:** Associate Professor

The effect of dietary supplementation of α – amylase and papain on growth, survival and bioenergetic parameters were evaluated for post-larvae of *Macrobrachium rosenbergii*. Post-larvae were fed with practical diet (35% protein) containing 0.1, 0.2, 0.3 and 0.4 % of α – amylase for Experiment – I and II and papain for Experiment-III and IV respectively. Diet without enzyme supplementation served as control. Experiment-I was conducted as per CRD to evaluate the effect of α – amylase supplemented diet on growth and survival of post larvae of *M. rosenbergii* for 42 days rearing period. Maximum length gain (53.61%), weight gain (194.51%) and SGR (2.57) were recorded for post-larvae fed with T₂ (0.2 %) diet and which was not significantly different (P > 0.05) from T₁ diet. ANOVA showed no significant difference (P > 0.05) in survival among the diets for Experiment-I.

Experiment-II was conducted in duplicate to evaluate the effect of α – amylase supplemented diet on bioenergetic parameter for post-larvae of *M. rosenbergii* for 10 days. Post-larvae fed with T₂ diet showed better FCR, PER, assimilation, gross growth efficiency, conversion rate and protein digestibility coefficient and found not significantly different (P > 0.05) from T₁ diet.

Experiment-III was conducted as per CRD to evaluate the effect of papain supplemented diet on growth and survival of post-larvae of *M. rosenbergii* for 42 days rearing period. Maximum length gain (18.36 %), weight gain (81.15%) and SGR (1.41%) were recorded for post-larvae fed with T₁ diet (0.1%) and found significantly different (P > 0.05) from T₀ diet but not significantly different (P > 0.05) from T₂, T₃ and T₄ diets. ANOVA showed no significant difference (P > 0.05) in survival among

the diets for Experiment-III.

Experiment-IV was conducted to evaluate the effect of papain supplemented diet on bioenergetic parameters. Post-larvae fed with diet T₁ (0.1%) showed better FCR, PER, assimilation, gross growth efficiency, relative growth rate, conversion rate and protein digestibility coefficient and significantly different from control diet (T₀).

The result of these feeding trials indicated that the 0.1% supplementation of α – amylase and papain to the diets resulted in better growth and feed utilization of post larvae of *M. rosenbergii*.

**Effect of some moult triggering compounds on larval rearing of
Macrobrachium rosenbergii (De Man, 1879)**

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. A.R. Sangle

Registration No.: 69

Year of thesis submission: 2004

Name of the research guide: Dr. S.T.
Indulkar

Designation: Associate Professor

The present investigations were carried out to assess the effect of iodine and BKC moult triggering compounds on the molting and survival from zoeal larvae of IV stage to post larvae of the giant freshwater prawn *M. rosenbergii*. In the first experiment, iodine was used as moult triggering compound at concentration of 0.01, 0.02 and 0.03 ppb. In the second experiment, BKC was used as moult triggering compound at concentration of 0.1 ppb, 0.2 ppb and 0.3 ppb).

The present work indicated that moult triggering compounds (iodine and BKC) has increased the survival and reduced time period is obtaining the post-larvae from IV stage of larvae of *M. rosenbergii*.

The study revealed that addition of either 0.02 ppb iodine or 0.1 ppb BKC during zoeal larval rearing of *M. rosenbergii* improve the survival and reduce the larval rearing period.

**Evaluation of jackfruit seed and cashew testa as ingredients in practical diet for
rearing the post larvae of *Macrobrachium rosenbergii* (De man, 1879)**

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Miss. S.B.
Belnekar

Registration No.: 75

Year of thesis submission: 2008

Name of the research guide: Dr.
H.T. Dhaker

Designation: Associate Professor

Experiments I and II were conducted to study the effect of jackfruit seed and cashew testa incorporated diet respectively on growth and survival of post-larvae of *M. rosenbergii* for 60 days. Experiment III was carried out for evaluating the bioenergetics parameters in the test diets during rearing of post-larvae of *M. rosenbergii*. Test diets were prepared by incorporating the jackfruit seed (5%, 10%, 20% and 40%) and cashew testa powder (5%, 10%, 20% and 40%) by reducing the level of fish meal while diet containing 30.41% fish meal used as control diet for experiment I and II. Post larvae were fed with 5% jackfruit seed incorporated diet showed significantly higher length gain, weight gain, specific growth rate and survival than other diets during experiment I, while in experiment II, post larvae were

fed with 10% cashew testa incorporated diet showed significantly higher length gain, weight gain, specific growth rate and survival as compared to other diets.

Experiment III revealed that feed conversion ratio, protein efficiency ratio, assimilation, assimilation efficiency, gross growth efficiency, net growth efficiency, relative growth rate, consumption/ unit and protein digestibility coefficient of posty larvae fed with 5% jackfruit seed incorporated diet while assimilation, assimilation efficiency, relative growth rate, consumption/ unit weight/ day and protein digestibility coefficient of post-larvae fed with 10% cashew testa incorporated diet were found significantly better than control diet. It can be concluded that fish meal can be replaced up to 5% by jackfruit seed and 10% by cashew testa in diet of post larvae of *M. rosenbergii*.

Studies on breeding and rearing of estuarine rice fish *Oryzias melastigma* (McClelland, 1839)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Miss. S.I. Darve

Registration No.: 76

Year of thesis submission: 2005

Name of the research guide: Dr. S.T.

Designation: Associate Professor

Indulkar

Breeding of *O. melastigma* in laboratory, its embryonic development, evaluate suitable feed and optimum salinity for its better growth and survival.

Experiment 1 Spawning of *O. melastigma* in laboratory usually occurred in the morning or at twilight. Eggs laid per clutch ranged from 05 to 76 numbers and size of the eggs ranged from 1.1 to 1.4 mm in diameter. Hatching of eggs required 07 to 21 days at temperature range of 21 to 29 °C and the size of hatchlings ranged from 4.34 to 4.48 mm in length.

Experiment 2 Twenty-four developmental stages of egg were observed based on their morphological differences. Hatchling stage was observed after 264 hours i.e. 11 days at 24 to 25 °C temperature.

Experiment 3 Effect of different types of feed such as flake feed, moist feed, mixed plankton and mosquito larvae was evaluated on growth and survival of *O. melastigma*. Higher length gain (49.0%), weight gain (644%), specific growth rate (6.67) and survival (100%) were observed in flake feed. Flake feed gave 4.47 per cent per day increment in growth and 36 per cent more survival than mosquito larvae.

Experiment 4 Effect of eight different salinities viz. 0, 5, 10, 15, 20, 25, 30 and 35 g L⁻¹ were tested to observe growth and survival of *O. melastigma*. Significantly higher length gain (33.26%), weight gain (163.06%) and specific growth rate (3.22) were observed in 10 g L⁻¹ salinity whereas, significantly lower length gain (13.41%), weight gain (99.20%) and specific growth rate (2.30) were observed in freshwater.

From the forgoing account it is concluded that *O. melastigma* can be bred under laboratory conditions and for full development of fertilised egg required eleven days at 24 to 25 °C temperature. It also indicated that *O. melastigma* can be reared on artificial feed under laboratory conditions. It can tolerate wide range of salinities (0 g L⁻¹ to 35 g L⁻¹) however, 10 g L⁻¹ salinity was found to be optimum for rearing of *O. melastigma*.

Lipid: Carbohydrate and protein: Energy diets for post-larvae of

***Macrobrachium rosenbergii* (De Man, 1879)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. A.M. Hodekar	Registration No.: 78
Year of thesis submission: 2005	
Name of the research guide: Dr. A.M. Ranade	Designation: Head and Professor

The effect of lipid:carbohydrate and protein:energy ratio in test diets on growth and survival were evaluated for post larvae of *M. rosenbergii*. post larvae were fed with four isonitrogenous (35% protein) and isocaloric (330 kcal 100 g⁻¹) test diets with four lipid:carbohydrate ratio 1:9.8, 1:4.6, 1:2.8, 1:1.3 in experiment I. in experiment II, post larvae were fed with different diets having constant lipid:carbohydrate ratio with different protein levels (30, 35 and 40 %) and energy levels (203, 223 and 263 kcal 100 g⁻¹) and corresponding protein:energy ratios (148, 157 and 171 mg protein kcal⁻¹). both the experiments were carried out as per CRD. maximum length gain, weight gain, specific growth rate, protein efficiency ratio, apparent protein retention and better feed conversion ratio were obtained for post larvae fed with diet (T₁) containing 1:9.8 lipid:carbohydrate ratio. Diet T₁ was significantly different (P<0.05) from T₂, T₃ and T₄ diets for length gain, food conversion ratio and protein efficiency ratio. ANOVA showed no significant difference (P>0.05) in survival between the diets for experiment I.

In experiment II, maximum length gain (33.67%), weight gain (169.92%), specific growth rate (3.29% per day), protein efficiency ratio (1.20), apparent protein retention (151.85) and better food conversion ratio (2.40) was recorded for post larvae fed with T₂ diet containing 157 mg of protein kcal⁻¹ of protein:energy ratio. Diet T₂ was significantly differed from T₁ and T₃ diet for length gain, weight gain, specific growth rate and apparent protein retention. Survival was not found significantly different between the diets.

**Attachment and nacre formation on the mabe implanted in fresh water mussel,
Lamellidens corrianus (Lea, 1834)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Ningthoukhong Hemchandra	Registration No.: 79
Year of thesis submission: 2005	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The effect of sediment depth, feeding ration and calcium hardness of water on *L. corrianus* for the mabe attachment, nacre formation on mabe and survival were studied. Experiment I was conducted to determine the effects of different sediment depth such as 0 cm (T₀), 3 cm (T₁) and 6 cm (T₂) on *L. corrianus*. The maximum nacre formation of 0.047 g was observed in 6 cm sediment depth.

In experiment II effects of the feeding ration on *L. corrianus* for mabe attachment and nacre formation on mabe were evaluated. The attachment of mabe was not affected due to variation in feeding rations. The nacre coating on mabe was found significantly different between the feeding rations.

Experiment III was conducted to evaluate the effects of different calcium hardness of water such as 220.47 mf L⁻¹ (T₀), 282.63 (T₁), 314.17 (T₂) and 338.18

(T₃) mg L⁻¹ on *L. corrianus*. The maximum survival was found in T₀, but no significant difference was observed due to calcium hardness. The maximum nacre coating of 0.073 g was observed in 338.18 mg L⁻¹ ca hardness and found significance different with other treatments.

**Effect of different levels of supplemental L-ascorbic aid in practical diet for
Deccan Mahasheer, *Tor khudree* (Skyes) fry**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.P. Jadhav	Registration No.: 81
Year of thesis submission: 2005	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

The effect of dietary supplementation of L-ascorbic acid on growth, survival and bioenergetic parameters were evaluated for fry of *Tor khudree*. Fry were fed with practical diet containing 0.05 (T₁), 0.10 (T₂), 0.20 (T₃), 0.04 (T₄) and 1.0 g/kg (T₅) of L-ascorbic acid for both the experiment I and II. Diet without L-ascorbic acid supplementation (T₀) served as control. Experiment I was conducted as per CRD to evaluate the effect of L-ascorbic acid supplemented diet on growth and survival of fry of *Tor khudree* for 42 days rearing period. Maximum length gain (94.03%), weight gain (883.77%), survival (86.67%) and SGR (5.44%) were recorded for fry fed T₄ (0.40 g/kg L-ascorbic acid) diet.

Experiment II was conducted in duplicate to evaluate the effect of L-ascorbic acid supplemented diet on bioenergetic parameters for fry of *T. khudree* for 42 days. Fry fed with T₄ diet showed better FCR, PER, assimilation, assimilation efficiency, gross growth efficiency, relative growth rate, conversion rate, protein digestibility co-efficient, lipid digestibility co-efficient, digestible energy, apparent protein retention, apparent lipid retention and were found significantly different from T₀, T₁, T₂, T₃ and T₅ diets.

The result of these feeding trails indicated that 0.40 g /kg L-ascorbic acid diet showed better growth, survival and feed utilization of fry of *Tor khudree*.

**Evaluation of compounded diets for fry to fingerling rearing of Deccan
Mahasheer *Tor khudree* (Skyes)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. G.S. Pathare	Registration No.: 85
Year of thesis submission: 2005	
Name of the research guide: Dr. S.T. Indulkar	Designation: Associate Professor

In the present study, attempts were made to evaluate the effect of diet forms, different compounded diets and probiotics on the growth, feed utilization and survival of mahseer fry, *Tor khudree* during 30 days of rearing period. In the first experiment, three forms of diet viz. ball, pellet and flake were used. The mahseer fry fed diets in the form of flakes and pellet showed significantly (P<0.05) higher growth than those fed diets in the form of ball. Significantly (P<0.05) higher survival was observed with flake diet than pellet and ball diets. In the second experiment, a control diet (T₀) was prepared using fish meat powder, prawn head meal, *Acetus* meal, groundnut oil cake each contributing 24.13%, wheat flour, rice bran each contributing 1.74 % and

vitamin 1%. Other four diets (T₁, T₂, T₃, and T₄) were prepared by replacing groundnut oil cake with soya cake at the rate of 25%, 50%, 75% and 100%. Significantly (P<0.05) higher growth and feed utilization were recorded with a diet formulated by 50% replacement of groundnut oil cake with soya cake (T₂). In the third experiment, effects of T₂ diet from second experiment without probiotics (T₀), with probiotics *Lactobascillus acidophiles* (T₁) and mixed strain of *Lactobascillus* spp. (T₂) were evaluated. No significant difference (P>0.05) was observed in the growth and survival of fry fed diets with and without probiotics.

Effect of some synthetic hormones on the survival and maturation of black tetra, *Gymnocorymbus ternetzi* (Boulenger, 1895)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Miss. V.S.

Registration No.: 105

Sawate

Year of thesis submission: 2008

Name of the research guide: Dr. H. T.

Designation: Professor and Head

Dhaker

The effects of some synthetic hormones incorporated in diet were studied for growth, survival and maturation of Black Terta *G. ternetzi*. In experiment I two synthetic hormones 17 α -methyltestosterone @ 1, 1.2 and 1.4 mg/kg and ethynylestradiol @ 1, 2 and 5 mg/kg were incorporated in diet and fed to 20 days old fry of *Gymnocorymbus ternetzi* for 90 days. Maximum length gain (203.68 %) and weight gain (620.95 %) and survival (70 %) were observed at 1mg/kg 17 α -methyltestosterone (MT₁) incorporated diet. Maximum gonado somatic index were 0.88 in male and 4.36 in female were observed at 1 mg/kg of MT₁ incorporated diet and showed significant difference (P<0.05). Maximum length gain (156.69 %) and weight gain (423.04 %) and survival (66.66 %) were observed at 1mg/kg ethynylestradiol (E₁) incorporated diet. Maximum gonado somatic index of 0.83 in male and 4.17 in female were observed at 1 mg/kg of E₁ incorporated diet and showed significant difference (P<0.05).

In experiment II, 19-norethisterone @ 10, 20 and 30 mg/kg diet, testosterone propionate @ 1, 3 and 5 mg/kg diet and thyroxin @ 3, 5 and 7 mg/kg diet were used to study their effect on growth and survival of Black Tetra *Gymnocorymbus ternetzi* for 60 days. Maximum length gain (171.93%) and survival (86.66%) were observed at 5 mg/kg thyroxin (TH₂) and weight gain (208.98%) were observed at 3 mg/kg of thyroxin (TH₁). TH₁ and TH₂ were significantly different (P<0.05) from all other diets. Maximum length gain (159.46%) were observed at 30 mg/kg of 19-norethisterone (N₃) and weight gain (201.36%) and survival (80%) at 20 mg/kg of 19-norethisterone (N₂). N₃ and N₂ incorporated diet showed significant difference (P<0.05) with other diets.

Testosterone propionate (TP₂) at 3 mg/kg showed the maximum length gain (159.23%) and survival (80%) and weight gain (184.94%) at 1 mg/kg of Testosterone propionate (TP₁). TP₂ and TP₁ incorporated diet showed significant difference (P<0.05) with other diets for length and weight gain whereas there was no significance difference between the survival percentage between the diets.

Effect of dietary inclusion of animal extracts on the growth and survival of

Penaeus monodon (Fabricus)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. V.B. Shikhare	Registration No.: 108
Year of thesis submission: 2007	
Name of the research guide: Dr. H.T. Dhaker	Designation: Professor and Head

The effect of dietary inclusion of animal extracts on the growth, survival and bioenergetic parameters were evaluated for tiger shrimp, *Penaeus monodon*. Experiments I and II were studied for growth and survival while experiments III and IV were conducted for bioenergetics study. Wet meat and dry meat extracts were prepared from Clam, *Paphia malabarica*, green mussel, *Perna viridis* and squid, *Loligo* spp. Shrimps fed the basal diet coated with 15, 30 and 60 ml kg⁻¹ of clam, mussel and squid wet meat extract for experiment I and III whereas dry meat extract for experiment II and IV. The growth and bioenergetic study was conducted for 70 and 15 days respectively. In experiment I, 30 ml kg⁻¹ clam and mussel wet meat extract diets were significantly better ($P<0.05$) compared to remaining diets for weight gain, length gain and specific growth rate. Experiment II showed that 60 ml kg⁻¹ clam and mussel dry meat extract diets were significantly ($P<0.05$) better for weight gain, length gain and specific growth rate than other diets. The survival rate showed no significant difference ($P>0.05$) between the different diets in both experiments. Experiment III revealed that feed conversion ratio, protein efficiency ratio, assimilation, gross growth efficiency, assimilation efficiency, conversion rate, protein digestibility coefficient, lipid digestibility coefficient, digestible energy and apparent lipid retention of *P. monodon* fed with 30 ml kg⁻¹ clam and mussel wet meat extract diets were significantly different ($P<0.05$) from control diet. Experiment IV indicated that *P. monodon* fed with 60 ml kg⁻¹ clam and mussel dry meat extract diets showed significantly ($P<0.05$) better feed conversion ratio, assimilation, gross growth efficiency, assimilation efficiency, relative growth rate, conversion rate, protein digestibility coefficient, digestible energy, apparent protein retention and apparent lipid retention compared to control diet. The diets coated with 30 ml kg⁻¹ wet meat extract of clam and mussel recorded the 10% increase in weight gain of *P. monodon* than the control diet during study period.

Effect of fish powder incorporated diets on larval rearing of *Macrobrachium rosenbergii* (de man, 1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. R.M. Togare	Registration No.: 111
Year of thesis submission: 2006	
Name of the research guide: Dr. S.T. Indulkar	Designation: Associate Professor

The investigation was carried out to assess the effect of various fish meat powders viz. ribbon fish (T₀), pink perch (T₁), croaker (T₂) and Bombay duck (T₃) incorporated diets on larval rearing of *M. rosenbergii* from IV zoeal stage to last post larval formation. Among the four fish meat powders used, diets incorporated with ribbonfish meat powder showed better larval progression, less period for completion of larval cycle and better survival as compared to others.

In the second experiment, assessment of effect of various concentrations (20,

25, 30, 35 and 40%) of ribbon fish meat powder and pink perch meat powder were tried in the larval diet for *M. rosenbergii*. The results indicated use of diets incorporated with 25 to 30 per cent ribbonfish meat powder or 35 to 40 per cent pink perch meat powder for larval rearing.

Diet consisting of fish meat powder (ribbonfish 25 to 30% or pink perch 35 to 40%), milk powder (20%), agar (2.0%), poultry egg (wet weight 28 to 43%), corn flour (8%), vitamin mineral (1%) and dry yeast (1%) can be served as best diet for the rearing of *M. rosenbergii*.

Genetic diversity and species-diagnostic markers of freshwater mussels in north Konkan region of Maharashtra determined by RAPD analysis

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. M.J. Nakhawa

Registration No.: 113

Year of thesis submission: 2007

Name of the research guide: Dr. H.T.

Designation: Associate Professor

Dhaker

The genetic diversity of freshwater mussel *L. corrianus* from Thane and Raigad Districts of north Konkan region of Maharashtra was studied. The samples were collected from four locations of Thane and three locations of Raigad Districts.

A total of 216 RAPD bands in the size range of 200 to 1500 bp were generated by five primers with 135 polymorphic bands (62.3%) and 81 monomorphic bands. Four primers generated species specific bands in all the samples of *L. corrianus*. The effective number of alleles, percentage polymorphism, Shannon's index and Nei's gene diversity for Thane district population were 1.4623, 62.65, 0.4222 and 0.2793, respectively. The effective number of alleles, percentage polymorphism, Shannon's index and Nei's gene diversity for Raigad district population were 1.3616, 61.66, 0.2877 and 0.2009, respectively. The degree of polymorphism reported to be high in the samples from Thane district than the samples from Raigad district. The results indicated higher genetic variability between two populations.

The average genetic similarity for Thane district population was 0.6621 and the average genetic similarity for Raigad district population was 0.6886. When the Thane population was compared with Raigad population the genetic similarity observed was 0.8862. The variation in genetic similarity values may indicate geographical isolation in the breeding populations of the freshwater mussel *L. corrianus* from different rivers.

The phylogenetic analysis revealed that the samples collected from two different locations of the same river were genetically closer, than the samples from two different rivers. The results of the present study revealed high genetic variability and low genetic differentiation among populations, thus suggesting a great potential for genetic homogenization within populations over large geographical distances.

Effect of salinity and temperature on breeding behaviour of Ricefish, *Oryzias melastigma* (McClelland, 1839)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Miss. A.S.

Registration No.: 114

Pawar

Year of thesis submission: 2007

Name of the research guide: Dr. S.T. Indulkar

Designation: Associate Professor

The present study deals with survival, growth and maturation of larvae of *Oryzias melastigma* reared in different salinities. It also includes the study on influence of salinity and temperature on development of embryos of *O. melastigma* to observe survival, hatching rate, viability of 24 h post hatch larvae and hatching period.

In the present experiment 20 days old young ones of *O. melastigma* were transferred in eight different salinity treatments viz. freshwater 5, 10, 15, 20, 25, 30 and 35 g.l⁻¹ salinity prepared by mixing naturally available seawater with freshwater. Observations on survival, weight gain, length gain, specific growth rate and gonado somatic index were made at the end of experiment. Similarly, eight test salinities were prepared for experiment II for incubation of embryos of *O. melastigma*. In the experiment III, eggs of *O. melastigma* were incubated at five different temperatures (20.0, 22.5, 25.0, 27.5, 30.0 °C) after six to seven hours of spawning. Observations on eggs hatching, viability, incubation period and survival were made daily.

The observations of the present study showed ability of the larvae to survive in wide range of salinity from 0 to 35 g.l⁻¹. However, better growth and early maturity observed in the salinity of 10 to 15 g.l⁻¹. The observations on the hatching rate and hatching period of embryos and viability of 24 hour post hatch larvae in different salinities and at different temperatures revealed optimal salinity of 0 to 10 g.l⁻¹ and temperature of 27.5 to 30 °C for egg incubation.

Phosphorus budget of shrimp culture ponds located at Nevare, District Ratnagiri

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. H. E. Raut

Registration No.: 115

Year of thesis submission: 2007

Name of the research guide: Dr. H.T. Dhaker

Designation: Professor and Head

The study was conducted in ponds located at Nevare, Ratnagiri from November 2006 to April 2007. Ten ponds were selected having area from 0.48 to 0.60 ha. The post larvae of *P. monodon* were stocked at 10 numbers/m² during November 2006. The post larvae were reared by using improved extensive type culture system. The sediment parameters before stocking were pH, 5.80 to 6.98; organic carbon, 0.75 to 1.82%; available nitrogen, 15.12 to 31.92 mg 100 g⁻¹ and available phosphorus, 11 to 49 mg 100 g⁻¹ while pH, 6.29 to 6.77; organic carbon, 1.42 to 2.47%; available nitrogen, 23.52 to 33.60 mg 100 g⁻¹; available phosphorus, 19 to 70 mg 100 g⁻¹ were found at harvest. The survival, specific growth rate, relative growth rate, weight gain, feed conversion ratio (FCR) were 58.16%, 5.86%, 20.77%, 28.87 g and 1.58, respectively for *P. monodon* in 142 days' study period. The carcass analysis of harvested *P. monodon* showed protein, 48.75%; Fat, 3.7 1%; Ash, 17.17%; Carbohydrate, 17.31% and phosphorus 1.13% during study period. The phosphorus sources in ponds were feed, fertilizer and water which accounted for 37% of the total input. While, output of phosphorus recorded was 16.61% in harvested shrimp, 12.12% in discharge water, 69.38% in sediment during culture period. The study revealed that major portion of input phosphorus was from feed where as, maximum phosphorus was trapped in the sediment of shrimp ponds at Nevare.

Studies on growth and survival of spawn and fry of Neon tetra,

***Paracheirodon innesi* (Mayers, 1936)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.V. Sanaye	Registration No.: 116
Year of thesis submission: 2007	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

In the commercial development of freshwater ornamental fish culture provision of appropriate live foods for feeding the fish at various stages is an important aspect in success of seed production. Growth and survival of spawn and fry of neon tetra, *Paracheirodon innesi* by using different live food organisms and formulated feed was evaluated during this study. Experiment I was conducted to determine the effect of infusoria and green water on growth and survival of spawn of neon tetra. The better growth (length gain 94.66%, weight gain 1120.49%, and specific growth rate (SGR) 19.24%) and 80% survival was observed in spawn fed green water for 13 days. In second experiment, thirteen day old neon tetra early fry (6.44 ± 0.025 mm initial lengths, 0.64 ± 0.0031 mg initial body weight) were fed mixed zooplankton (T₁), decapsulated *Artemia* cyst (T₂) and *Artemia* nauplii. (T₃). Survival was 95.23% on T₁ (mixed zooplankton), 37.33% on T₂ (decapsulated *Artemia* cyst), and 67.61% on T₃ (*Artemia* nauplii). The better growth (length gain 131.98%, weight gain 6658.78% and SGR 14.04%) was observed in early fry fed mixed zooplankton for 30 days. During the third experiment, fry neon tetra was weaned from mixed zooplankton to formulated feed. Neon tetra fry (14.62 ± 0.27 mm initial length, 40.09 ± 2.72 mg initial body weight) were fed with mixed zooplankton (D₁) and formulated feed (D₂), and in case of weaning treatments i.e. weaning at day 24 (D₃), the reduction in quantity of mixed zooplankton were performed at day 12, 18 and 24. The quantity of mixed zooplankton was provided @ 66 numbers fry⁻¹ and after 12 days it was reduced to half i.e. 33 numbers fry⁻¹ and formulated feed was provided at the rate of 2% of the biomass. At 18 days the quantity of mixed zooplankton reduced to half of the previous quantity and at day 24 mixed zooplankton was completely replaced by formulated feed. Similarly for weaning treatment D₄ (weaning at day 12), these changes were made at day 6, 9 and 12 and for weaning treatment D₅ (weaning at day 6) at day 2, 4 and 6. The mean lengths were highest in fry weaned at day 6 (21.13 ± 0.14 mm), significantly different from other treatments, while mean weights, SGR and survival were found better in D₅ and significantly different from control. This study showed that replacement of mixed zooplankton by formulated feed at day 6 appears feasible.

Effect of tank colouration on metamorphosis, growth and survival of larvae of *Macrobrachium rosenbergii* (De man, 1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S.T. Shelke	Registration No.: 117
Year of thesis submission: 2007	
Name of the research guide: Dr. S.T. Indulkar	Designation: Associate Professor

Effect of different tank colours viz. white, red, blue, dark violet, gray and

green on metamorphosis and survival of zoeal larvae of *M. rosenbergii* was assessed in the first experiment. Significantly reduced metamorphosis period and higher survival were observed in darker internal colour of rearing tubs. Similarly effects different colours of tubs viz. white, red, green, blue and dark violet on growth and survival of post larvae was observed. The dark violet coloured rearing tubs recorded higher growth and survival of post larvae.

The role of colour of rearing tub and its interaction with light intensity appears to be important in metamorphosis and survival of zoeal larvae and post larvae of *M. rosenbergii*.

Effect of dietary inclusion of freshwater mussel extracts on the growth and survival of post larvae of *Macrobrachium rosenbergii* (De man, 1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. A. K. Chaudhari	Registration No.: 131
Year of thesis submission: 2008	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

The effect of dietary inclusion of freshwater mussel extracts on the growth, survival and bioenergetic parameters were evaluated for post larvae of freshwater prawn, *Macrobrachium rosenbergii*. Experiment-I and II were studied for growth and survival, while experiment-III was conducted for bioenergetics study and experiment-IV for evaluation of dietary attractability in *M. rosenbergii*. Freshwater mussel, *Lamellidens marginalis* was used for preparation of extracts. Prawns were fed with extract coated basal diet at three concentrations of wet meat and roasted meat extracts (20, 30 and 40 ml kg⁻¹) for experiment-I and dried meat powder extract coated diet at 20, 30, 40, 50, 60 and 70 ml kg⁻¹ concentrations for experiment-II. The best diets from experiment-I and experiment-II along with control diet were used for experiment-III. The growth and bioenergetics study were conducted for 70 and 15 days respectively. In experiment-I, 30 ml kg⁻¹ wet meat and in experiment-II, 60 ml kg⁻¹ dried meat powder extract coated diets were found better than other diets for weight gain, length gain and specific growth rate. The survival rate showed no significant difference among the different diets in both experiments. Experiment-III revealed that FCR, PER, assimilation, assimilation efficiency, gross growth efficiency, relative growth rate, protein digestibility coefficient, apparent protein retention and apparent lipid retention of *M. rosenbergii* fed with 30 ml kg⁻¹ wet meat extract coated diet was significantly better than control diet. Experiment-IV revealed that prawns were more attracted towards diet coated with 30 ml kg⁻¹ wet meat extract than other diets. It is concluded that diet coated with 30 ml kg⁻¹ wet meat and 60 ml kg⁻¹ dried meat powder extract of freshwater mussel were found better for increasing the growth of post larvae of *M. rosenbergii* under laboratory conditions.

Effect of alum on the pond turbidity, survival and growth of IMC at Panvel

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. P.U. Kapse	Registration No.: 132
Year of thesis submission: 2008	
Name of the research guide: Dr. P.E.	Designation: Associate Professor

Alum is more effective and economical in removing clay turbidity from pond water sample. Therefore, a simple alum requirement test was standardized to determine the amount of alum needed to floc clay particles in pond water. Alum requirement was 27 mg/L for pond water of Kharland Research Station, Panvel. Accordingly the dose of alum was standardized to undertake further studies on growth and survival of fry and semifingerling of *C. catla* compared to turbid water.

Alum treatment of turbid water caused marked reduction of turbidity in both experiments on growth and survival of fry and semifingerling of *C. catla*. Each mg/L of alum destroyed approximately 0.47 and 0.53 mg/L of total alkalinity in experiment of fry rearing and semifingerling rearing respectively and thereby depressed pH.

The lengthwise and weightwise growth of fry of *C. catla* was significantly higher in alum treatment than that of turbid water. In alum treatment, absolute growth (6.04 mm in length and 85.50 mg in weight), relative growth (lengthwise 0.27 mm and weightwise 0.94 mg), and per day increment in growth (0.40 mm in length and 5.70 mg in weight), of fry was more than the absolute growth (3.96 mm in length and 39.63 mg in weight), relative growth (lengthwise 0.18 mm and weightwise 0.43 mg), and per day increment in growth (0.26 mm in length and 2.64 mg in weight), of fry in turbid water.

The lengthwise and weightwise growth of semifingerling of *C. catla* was significantly higher in alum treatment than that of turbid water. In alum treatment, absolute growth (14.86 mm in length and 706.06 mg in weight), relative growth (lengthwise 0.47 mm and weightwise 2.39 mg), and per day increment in growth (0.49 mm in length and 23.53 mg in weight), of fry was more than the absolute growth (11.62 mm in length and 537.83 mg in weight), relative growth (lengthwise 0.36 mm and weightwise 1.82 mg), and per day increment in growth (0.38 mm in length and 17.92 mg in weight), of fry in turbid water.

The survival of fry and semifingerling of *C. catla* was 80.57 % and 94 % respectively in alum treatment, while it was 72 %, and 92 % respectively in turbid water.

Result of present study indicated that the application of alum @ 27 mg/L is useful to decrease the turbidity and increase the survival and growth of fry and semifingerling of *C. catla*.

Stocking density and feeding ration of *Liza parsia* (Hamilton-Buchanan, 1822) fry in cages

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. S.O.
Khairnar

Registration No.: 133

Year of thesis submission: 2008

Name of the research guide: Dr. P.E.

Designation: Associate Professor

Shingare

In experiment I, goldspot mullet (*Liza parsia*) were reared at three different densities in the cages (1 x 1x 0.5 m⁻³) to evaluate the effects of stocking density on growth and survival. Fry (mean length, 1.3 ± 0.2 cm and mean weight, 0.08 ± 0.03 g) were stocked at the rate of 50, 100 and 200 nos. m⁻² for 30 days. the final mean lengths were 3.40, 2.75 and 2.46 cm, mean weights were 0.6125, 0.5042 and 0.4055, SGR was 6.01, 5.40 and 4.77 % day⁻¹ and survival were 80.57, 72.42 and 60.14%

respectively at stocking densities of 50, 100 and 200 nos. m⁻². The results revealed that stocking density showed inverse relationship with growth (length gain, weight gain and specific growth rate) and survival.

In experiment II, fry were stocked at 50 nos. m⁻² in cages (1 x 1 0.5 m²) with mean length, 1.3 ± 0.4 cm and mean weight, 0.08 ± 0.003 g to evaluate the effect of different feeding ration viz. 4, 6, 8 and 10 % of body weight⁻¹ on growth and survival. Fry were nursed in cages until they reached one gram weight. Among the four different feed rations, fry fed at 6% of body weight⁻¹ attained highest average length of 4.46 cm, average weight of 1.03 g and specific growth rate (SGR) of 7.03% day⁻¹ in 36 days, with 76.8% of survival. The results showed that, length gain, weight gain and specific growth rate were found significantly different among feeding ration and survival showed non significance among the feeding rations.

Effect of dietary inclusion of green mussel and clam extracts on the growth and survival of *Macrobrachium rosenbergii* (De man, 1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. V. D. Mhatre	Registration No.: 134
Year of thesis submission: 2008	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

Experiment I and II, were conducted to study the effect of dietary inclusion of green mussel (*Perna viridis*) and clam (*Paphia malabarica*) wet and dry meat powder extracts on growth and survival of freshwater prawn, *M. rosenbergii* was evaluated. After 70 days of laboratory experimental culture duration significantly higher weight gain, length gain and specific growth rate was recorded with 30 ml kg⁻¹ clam and mussel wet meat extract incorporated diets. The dietary inclusion of 60 ml kg⁻¹ clam and mussel dry meat powder extracts shown better results for weight gain, length gain and specific growth rate. Experiment III was carried out to study the effect of different diets on bioenergetic parameters of *M. rosenbergii*. Results showed that prawns fed with 30 ml kg⁻¹ clam wet meat extract incorporated diet showed significant difference in feed conversion ratio, protein efficiency ratio, assimilation, assimilation efficiency, relative growth rate, gross growth efficiency, protein digestibility coefficient, apparent protein retention and apparent lipid retention as compared to other diets. Experiment IV was conducted to study the dietary attraction of *M. rosenbergii* by using the mussel and clam extracts coated diets. Maximum attraction of *M. rosenbergii* was found with the diet incorporated with clam wet meat extract at 60 ml kg⁻¹ feed as compared to other diets.

During present study it was found that diet coated with 30 ml kg⁻¹ clam wet meat extract and 60 ml kg⁻¹ clam dry powder meat extract was better as compared to other diets.

Effect of stocking density on survival and growth of Goldfish (*Carassius auratus*) in floating cages

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Chandan Kumar	Registration No.: 135
Year of thesis submission: 2008	
Name of the research guide: Dr.	Designation: Associate Professor

The experiments were carried out on rearing of three important life cycle stages viz. spawn, fry and semi-fingerlings of goldfish, *Carassius auratus* at different stocking densities in floating cages (1mx 0.5mx 0.5m) installed in earthen pond. In the first experiment, spawn (mean length, 1.08 ± 0.02 cm and weight, 0.018 ± 0.0004 g) were grown at density of 200, 400 and 800 spawn m^{-3} for the period of 35 days. Fish were fed flake feed containing 53% crude protein at the rate of 8% of the body weight per day. The maximum mean length gain 194.54%, weight gain 11987.12%, specific growth rate 13.63 day^{-1} and mean survival 68% was recorded for spawn reared at density of 200 spawn m^{-3} . The growth and mean survival of spawn reared at density of 200 spawn m^{-3} were significantly ($p < 0.05$) better than those reared at densities of 400 and 800 spawn m^{-3} . The stocking densities showed significantly inverse relationship with growth (mean length gain, weight gain and specific growth rate) and mean survival. In the second experiment, fry (mean length, 2.55 ± 0.02 cm, and weight, 1.36 ± 0.047 g) were reared at three different stocking densities of 100, 200 and 400 fry m^{-3} for period of 42 days. The fry were fed moist feed containing 29 % crude protein at the rate of 6% of the body mean weight per day. The fry reared at a density of 100 fry m^{-3} showed significantly higher mean length gain 89.42%, weight gain 103.21% specific growth rate $1.69\% \text{ day}^{-1}$ and mean survival 69.14% than the fry stocked at the rate of 200 and 400 fry m^{-3} . The stocking densities showed significantly inverse relationship with growth (mean length gain, weight gain and specific growth rate) and mean survival. The third experiment was carried out with semi-fingerlings (mean length, 4.03 ± 0.02 cm and weight 2.09 ± 0.01 g) stocked at the rate of 50, 100 and 200 semi-fingerlings m^{-3} . The fishes were fed with moist feed containing 29% crude proteins at the rate of 4% of the body mean weight for duration of 49 days. These semi-fingerlings reared at density of 50 fingerlings m^{-3} displayed significantly higher mean length gain 57.47%, weight gain 181.48%, specific growth rate of $2.11 \% \text{ day}^{-1}$ and mean survival of 70.86% compared to semi-fingerlings reared at 100 and 200 numbers m^{-3} . The stocking densities showed significantly inverse relationship with growth (mean length gain, weight gain and specific growth rate) and mean survival.

The present investigation indicated that the stocking densities of 200 spawn m^{-3} , 100 fry m^{-3} and 50 semi-fingerlings m^{-3} yields better mean growth and mean survival in floating cages installed in earthen ponds.

**Evaluation of the efficiency of freshwater mussel, *Lamellidens marginalis*
(Lamarck, 1819)
as a biofilters**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. S. A. Gandhi	Registration No.: 148
Year of thesis submission: 2009	
Name of the research guide: Shri. D.I. Pathan	Designation: Assistant Professor

In the present study, efforts were made to evaluate the filtration capabilities of freshwater mussel, *Lamellidens marginalis*. The filtration rate of the mussel and effect of their densities on water parameters and nutrients were evaluated. In evaluation of filtration rate with respect to different algal cell densities and with respect to different freshwater mussel sizes, highest filtration rate (0.7 Lhr^{-1}) was observed in large size (10.18 ± 0.42 cm) mussels when fed with 1.5×10^6 cells mL^{-1} of mixed algae, which

was significantly different ($P > 0.05$) from all other treatments.

In 30-days duration, water quality parameters of mussel treated tanks like DO, alkalinity, total hardness, pH, TSS, nitrate-nitrogen, nitrite-nitrogen and orthophosphate showed decreasing trend and values of parameter like ammonia nitrogen drifted to higher values with respect to time. The SNK showed that, values of DO, alkalinity, nitrite-nitrogen, orthophosphate in control tanks were found to be significantly different ($P > 0.05$) from all other treatments, where other parameters did not show significant difference among each other.

It is concluded that the freshwater mussel has ability to clear the algal densities and gives better results when large size (shell length of 10.18 ± 0.42 cm) mussels are used. The study also showed that the mussel has ability to decrease nutrient content by converting complex nutrients to water soluble forms (ammonia, nitrate, and nitrite) and hence maintain the good water quality.

Effect of feed cycling on growth and survival of *Catla catla* (Hamilton, 1822)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. S. P.
Kamble

Registration No.: 149

Year of thesis submission: 2009

Name of the research guide: Dr. H.T. Dhaker
Designation: Head and Professor

In commercial aquaculture diet costs about 30-70% of total operational cost, hence it is important to develop the feeding strategy which optimizes feed efficiency and production, and maximizes profitability. The present study was designed to evaluate the effect of feed cycling on growth and survival fry and fingerling of *Catla catla*. The fry and fingerling were fed with two days (T_1), four days (T_2), six days (T_3) and eight days (T_4) feed cycles for both the Experiment-I and II respectively. Continuous feeding served as control (T_0). Experiment-I was conducted as per the CRD to evaluate the effect of feed cycling on growth and survival of fry of *Catla catla* for 60 days rearing period. During Experiment-I two days feed cycling regime (T_1) showed the better results for growth and survival. FCR and ECI were found better in T_4 . PER, LER and FI were found maximum in T_4 . FE found maximum in T_0 while condition factor (0.85) was not significant ($P > 0.05$) among all the treatments. Body composition was found best in control except RNA/DNA ratio found best in control, two days and four days feed cycling regimes. Experiment-II was conducted as per the CRD to evaluate the effect of feed cycling on growth and survival of fingerling of *Catla catla* for 60 days rearing period. During Experiment-II two days feed cycling regime (T_1) showed better results for growth, survival, biological parameters and body composition.

The present study indicated that two days feed cycling was found to be most suitable for growth, survival and body composition of fry and fingerling of *Catla catla*.

Use of surimi processing wastewater for culture of live food organisms

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Mansoor A. Rather	Registration No.: 150
Year of thesis submission: 2009	
Name of the research guide: Shri. D.I. Pathan	Designation: Assistant Professor

Utilization of food processing wastes for biological production will ease a part of the disposal problem; in particular the potential hazards of eutrophication, at the same time recycle the innately rich plant nutrients in the waste materials in the form of plant and animal biomass. Initially the composition profile of the surimi waste water was estimated. experiment I, II and III were conducted to evaluate the efficiency of different varieties i.e. untreated, treated and sludge of surimi waste water as a potential nutrient for culture of live food organisms including both zooplankton and phytoplankton. In all the three experiments surimi wastewater was used at five different concentrations i.e. 0%, 5%, 10%, 20% and 40% in T0, T1, T2, T3 and T4 respectively for the culture of mixed algae. Culture of mixed algae was carried out in plastic tubs by using common fertilizer GOC (Hemchandra, 2005), which served as control. Experiments I and II revealed that both untreated and treated surimi wastewater at 5% are better nutrients for culture of mixed algae. While the experiment III revealed that sludge is not a suitable nutrient for culture of live food organisms. In experiments IV and V mass culture of mixed algae was carried out using 5% concentration of treated and untreated surimi wastewater. The mixed algae were evaluated for cell densities on daily basis; also the mixed algae were assessed for specific growth rate, mean growth rate and doubling per day. In experiment VI and VII culture of mixed zooplankton was carried out at 5% concentrations of untreated surimi wastewater and it was considered for maximum density. Moreover the proximate composition of the surimi wastewater grown algae was found to be analogous to the algae grown on diverse commercial media.

Studies on growth and survival of Dwarf rainbowfish, *Melanotaenia praecox* (Weber and Beaufort, 1922)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. H. D. Patil	Registration No.: 151
Year of thesis submission: 2009	
Name of the research guide: Dr. P.E. Shingare	Designation: Associate Professor

Ornamental fish culture is a growing business all around the globe. Provision of appropriate food at different larval and post larval stages is an important aspect in success of seed production. Growth and survival of larvae of dwarf rainbowfish, *Melanotaenia praecox* using different live food organisms and formulated feed at different life stages was evaluated during the study. Experiment I was conducted to determine the effect of different live foods viz. Green water, Infusoria, decapsulated *Artemia* cysts, *Artemia* nauplii and mixed zooplankton. The higher length gain 355.56 % (± 29.39), weight gain 88.77 % (± 4.59), SGR 2.11 % (± 0.04) and 70 % (± 5.8) survival were observed in larvae fed with Infusoria \rightarrow decapsulated *Artemia* cysts \rightarrow *Artemia* nauplii \rightarrow mixed zooplankton for 30 days. In experiment II, fry of

dwarf rainbowfish, *M. praecox* were weaned from mixed zooplankton to formulated feed in 30 days. Dwarf rainbowfish fry (1.85 ± 0.008 cm initial length, 0.13 ± 0.001 g initial weight) were fed with mixed zooplankton (T₁) and formulated feed (T₂) and weaned from mixed zooplankton to formulated feed at day 6 (T₃), at day 12 (T₄) and at day 24 (T₅). Higher length gain 47.02 % (± 3.94), weight gain 168.28 % (± 9.45), SGR 3.28 % (± 9.45) and survival (100 %) were observed for the fry weaned at day 12. In experiment III, juvenile of dwarf rainbowfish (initial length = 2.23 ± 0.049 cm, initial weight = 0.13 ± 0.002 g) *M. praecox* were observed for growth and survival with varying dietary protein levels viz. 37% (T₁), 40% (T₂), 43% (T₃), 46% (T₄) and 49% (T₅). Juveniles fed 46% protein showed higher length gain 28.29 % (± 5.61), weight gain 125.68 % (± 36.60) and SGR 2.59 % (± 0.51) and survival (100%).

Studies on growth and survival of pearl Gourami, *Trichogaster leeri* (Bleeker, 1852)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Sangipran Baishya	Registration No.: 152
Year of thesis submission: 2009	
Name of the research guide: Dr. H.T. Dhaker	Designation: Associate Professor

Ornamental fish culture is a growing business all around the globe. For the growth and survival of any cultured varieties provision of proper nourishment holds the key to success in seed production. Growth and survival of larvae of pearl gourami, *Trichogaster leeri* using different live food organisms and formulated feed at different life stages were evaluated during the study. Experiment I was conducted to determine the effect of different live foods viz. Green water, Infusoria, decapsulated *Artemia* cysts, *Artemia* nauplii and mixed zooplankton. The improved growth (length gain 427.77 ± 11.34 %, weight gain 88.32 ± 4.59 % and SGR 2.11 ± 0.08 %) and survival (78.75 ± 2.39 %) were observed in spawn fed Greenwater → decapsulated *Artemia* cysts → *Artemia* nauplii → mixed zooplankton for 30 days. During the second experiment, fry of pearl gourami, *T. leeri* were weaned from mixed zooplankton to formulated feed in 30 days. Pearl gourami fry (1.6 ± 0.06 cm initial length and 0.39 ± 0.003 g initial body weight) were fed with mixed zooplankton (T₁) and formulated feed (T₂) and weaned from mixed zooplankton to formulated feed at day 6 (T₃), at day 12 (T₄) and at day 24 (T₅). Higher length gain (128.12 %), weight gain (116.15 %), SGR (2.57 %) and survival (97.50%) were observed for the fry weaned at day 24. During the third experiment, juvenile of pearl gourami, *T. leeri* were observed for growth and survival with varying dietary protein levels viz. 25% (T₁), 30% (T₂), 35% (T₃), 40% (T₄), 45% (T₅) and 50% (T₆). The juveniles of pearl gourami, *T. leeri* (initial length 3.2 ± 0.02 cm and initial weight 2.00 ± 0.02 g) fed 40% (T₄) protein diet showed better growth (length gain 55.46 ± 1.49 %, weight gain 138.75 ± 2.39 % and SGR 2.90 ± 0.03 %) and survival (100%).

**Effect of different organic manures on the growth of Screw Vallisneria,
Vallisneria spiralis Linne 1753**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. G. S. Shelar	Registration No.: 153
Year of thesis submission: 2009	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head of the Department

The aim of this study is to determine the role of different organic manures *viz.* raw cattle dung, poultry waste and vermicompost on the growth of *Vallisneria spiralis* in the container in open and shadow environmental condition.

Experiment I was conducted to study the role of different organic manures *viz.* cattle manure, poultry manure and vermicompost on the growth of *V. spiralis* in 100 g capacity pot for 28 days. All the manures were applied at the rate of 2 g pot⁻¹. Significant difference was not found among the treatments for water parameters, while significant difference was observed for nutrients of soil. Plastic pools manured with poultry and cattle manure did not show significant difference for final biomass, total length, number of leaf and runners of *V. spiralis*.

Experiment II was carried out to standardize the dose of cattle manure *viz.* 1 g pot⁻¹, 2 g pot⁻¹, 3 g pot⁻¹, 4 g pot⁻¹ and without cattle manure (control) was used for growth of *V. spiralis*. Significant difference was observed in growth parameters of *V. spiralis*. It was observed that 2 g pot⁻¹ cattle manure was good for optimum growth of the plant.

Experiment III was to study the effect of open and shadow environmental conditions on the growth of *V. spiralis*. Results indicated that *V. spiralis* grown in shadow conditions grew faster with dark green leaves than open environmental conditions.

It was concluded that the application of cattle manure at the rate of 2 g pot⁻¹ with soil in shadow conditions increase biomass, total length and produced good leaf quality of *V. spiralis*.

**Influence of temperature on some biological parameters of *Perna viridis*
(Linnaeus, 1758)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Vijay A.R.	Registration No.: 154
Year of thesis submission: 2009	
Name of the research guide: Dr. G.N. Kulkarni	Designation: Associate Professor

Static bioassay was conducted for *Perna viridis* for 96hr LT₅₀ at different temperatures. The 96hr LT₅₀ value of temperature for *P. viridis* was 31.35°C. 10, 30, 75 and 100% mortality was recorded at 30, 31, 32 and 32.5°C at the end of 96hr. Oxygen consumption rate of *P. viridis* were examined in relation to temperature. The green mussel *P. viridis* showed oxygen consumption rate 0.3 to 0.4mg/l at 28°C, 0.53 to 0.93 mg/l at 30°C with a further increase from 0.63 to 1.14 mg/l at 31°C. Lowest oxygen consumption rate was recorded at 28°C, while the highest was at 31°C after 1hr. The filtration rate of *P. viridis* was determined in relation to temperature (28, 30 and 31°C) at fixed phytoplankton concentration (1X10⁶cells/ml). The filtration rate of *P. viridis* varied from 2.4748 to 2.553 l/h/animal, 2.6389 to 2.7321 l/h and 2.6674 to

2.7761 l/h/animal at 28, 30 and 31°C respectively. Filtration rate increased as the temperature increased in all the exposures during the period of experiment, thus a direct relationship between temperature and filtration rate in *P. viridis* is discreditable. The filtration rate of *P. viridis* was determined in relation to varying phytoplankton concentration at 28°C. The filtration rate increased with increasing algal cell concentration until 1×10^5 cells/ml/animal, after which there was rapid decline at 1.25×10^5 cells/ml/animal. Filtration rate of *P. viridis* at 7.5×10^4 cells/ml was minimal and varied from 2.3925 to 2.4596 l/h/animal and peaked at 1×10^5 cells/ml/animal attaining 2.4295 to 2.45967 l/h/animal while the lowest was from 2.1992 to 2.2587 l/h/animal at 1.25×10^5 cells/ml/animal.

Young mussels of size 2.5 - 2.7 cm were reared at different temperature of 28°C (C), 30°C (T₁) and 31°C (T₂) at 1×10^5 cells/ml/animal for a period of 30 days. Growth of *P. viridis* was nearly same between Control, T₁ and T₂. Slight gradual increase in the growth rate of *P. viridis* up to 30°C was followed by decrease at 31°C.

Young mussels of size 2.5 - 2.7 cm were maintained at 28°C in the laboratory fed on three combinations of phytoplankton concentrations 1×10^5 , 1.25×10^5 and 1.50×10^5 Cells/ml/animal. The statistical test suggested a maximum growth rate of *P. viridis* at 1.50×10^5 while the least was at 1×10^5 cells/ml/animal. Growth rate increased as increase in phytoplankton concentration at 28°C.

**Effect of different diets on reproductive performance of pearl gourami,
Trichogaster leerii (bleeker, 1852)**

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. M. S. Bhalekar

Registration No.: FRRTM080161

Year of thesis submission: 2010

Name of the research guide: Shri. D.I. Pathan

Designation: Assistant Professor

The brood stock management is of prime concern in a hatchery system as the production of viable and quality seed is largely dependent upon the practices followed. In the present study, brood stock of *Trichogaster leerii* were fed with live food alone or in combination, as well as with enriched live food to assess the reproductive performance. The experiment was conducted in all glass aquarium tank ($60 \times 30 \times 30$ cm, 54-Lcapacity) filled with water up to a level of 15 cm. During the experiment I, the adult females of pearl gourami (length 5.80 ± 0.06 cm and weight 1.9207 ± 0.08 g) were fed with different live foods such as mosquito larvae (T₁), *Artemia* (T₂), earthworms (T₃) and combinations of the above food viz. mosquito larvae + *Artemia* (T₄), mosquito larvae + earthworm (T₅) and *Artemia* + earthworm (T₆). The fishes were fed up to satiation (about 8 to 10% of body weight) divided into three rations per day. The results indicated higher growth rate and reproductive performance in adult females of pearl gourami fed with mosquito larvae, as compared to other test diets. The culture of *Artemia* along with its enrichment to improve the nutritional status can be carried out easily. In experiment II, the adult females of pearl gourami (length 5.70 ± 0.07 cm and weight 1.9417 ± 0.11 g) were fed with different enriched on-grown *Artemia* viz. emulsion of cod liver oil and ground nut oil cake, *spirulina* powder, EPA/DHA medium. The results of the experiment II, revealed higher reproductive performance in term of spawn production of *T. leerii* fed with *Artemia* enriched with cod liver oil and ground nut oil cake emulsion. Therefore, use

of enriched *Artemia* with emulsion of cod liver oil and ground nut oil cake for better reproductive performance of brood stock of *T. leerii* is recommended.

Studies on growth and survival of flowerhorn fry

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. M. T. Chaudhari	Registration No.: FRRTM0162
Year of thesis submission: 2010	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

Flowerhorn is a crossbred fish between *Cichlasoma trimaculatum* and other cichlid species. Flowerhorn is one of the most popular among the aquarium hobbyist and fetches good price in ornamental fish market. Thus, attempts were made to breed flowerhorn in laboratory and study the embryonic development, evaluate suitable feed and feeding protocol for rearing the fry for its better growth and survival. Eggs laid per clutch was ranged from 5-20 numbers and ovoid shape, with the horizontal axis longer (1.38 ± 0.05 mm) than the vertical axis (1.78 ± 0.04 mm). During study, the different embryonic stages were observed such as fertilized egg, zygote stage, two-blastomere, four-blastomere, eight-blastomere, sixteen-blastomere, thirty-two blastomere stages, early-blastula stage, late-blastula stage, germ ring stage, embryonic-shield stage, 75% epiboly stage, yolk-plug stage, tail-bud stage, six-somite stage, twenty-four somite stage, pre-hatching stage, while larval stages were post-hatching stage, blood circulation stage, yolk-sac stage, opened-mouth stage and free swimming stage were recorded. The complete hatching was observed within 42-49 hours. While free swimming hatchling were recorded after 132 hours during the present study. Fry of flowerhorn (0.9 ± 0.04 cm initial length and 0.0163 ± 0.0002 g initial body weight) were fed with *Artemia* nauplii (T₀) and formulated feed (T₁) and weaned from *Artemia* nauplii to formulated feed at day 6 (T₂), at day 12 (T₃) and at day 24 (T₄). Higher length gain ($85.13 \pm 1.56\%$), weight gain ($420.73 \pm 1.95\%$), SGR ($5.50 \pm 0.015\%$) and survival (100.00%) were observed for at day 12 in rearing period of 30 days. The fry of flowerhorn (initial length 2.2 ± 0.006 cm and initial weight 0.163 ± 0.0002 g) fed 60% (T₄) protein diet and found better growth (length gain $58.77 \pm 0.30\%$, weight gain $546.98 \pm 35.92\%$ and SGR $3.10 \pm 0.09\%$) and survival (100%) in 60 days.

Role of Different Compounds in Formulation of Artificial Sea Water for Larval Rearing of *Macrobrachium rosenbergii* (De Man, 1879)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. V. S. Jogale	Registration No.: FRRTM0164
Year of thesis submission: 2010	
Name of the research guide: Shri. D.I. Pathan	Designation: Assistant Professor

The inland areas have tremendous potential of increasing freshwater prawn culture. Non-availability of quality seed in required quantity is one of the biggest constraints in the development of freshwater prawn culture in the state. Increased cost of seed transportation from coastal to remote inland areas and resulting stress of long distance transport on prawn seed are the main hurdles faced by the industry. Therefore, it is necessary to find an alternative option to make available artificial

seawater at lower cost in non-costal districts or states. Therefore, during present study an attempt was made to evaluate the effect of each element in formulated artificial seawater media growth and survival of *M. rosenbergii* larvae.

The media for one litre consisted of chemical composition as Common salt (42.00 g), Potassium chloride (1.0 g), Calcium chloride (1.8 g), Magnesium chloride (8.0 g), Sodium bicarbonate (0.34 g), Potassium bromide (0.16 g) and Ethylene Diamine Tetra Acetic acid [EDTA] (0.004 g) gave better results during larval rearing. In the experiment I, larvae were reared in container filled with 5 litre of different ASW formulation. Highest survival of 30% with production rate of 15 postlarvae L⁻¹ was recorded in ASW formulation devoid of Sodium sulphate compared to other formulations. In the experiment II, mass culture of larvae was carried out in plastic pool filled with 300 litre of ASW formulation devoid of Sodium sulphate. The larval survival of 12.01% was recorded with production rate of 10.98 postlarvae L⁻¹.

The present study indicated that the potential of the above mentioned ASW formulation without Na₂SO₄ element can be effectively used for larval rearing of *Macrobrachium rosenbergii* in the areas far away from costal region at a reasonable production cost.

Effect of dietary protein and lipid level on growth, feed efficiency and survival of flowerhorn fish

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. A. A. Murkar

Registration No.: FRRTM090177

Year of thesis submission: 2011

Name of the research guide: Dr. H.T.

Designation: Head and Professor

Dhaker

Flowerhorn is a crossbred fish which does not occur in the natural habitat. The fish became popular among aquarium keepers due to its natural beauty and its ability to grow in a wide range of environmental condition. In Experiment I, the juveniles of flowerhorn (average length = 3.6 ± 0.03 cm and weight = 1.15 ± 0.03 g) were fed nine different diets containing different protein and lipid level viz., 40%P5%L (T₁), 40%P10%L (T₂), 40%P15%L (T₃), 50%P5%L (T₄), 50%P10%L (T₅), 50%P15%L (T₆), 60%P5%L (T₇), 60%P10%L (T₈) and 60%P15%L (T₉) for 60 days . The better growth was observed in diet 50%P10%L (length gain $62.69 \pm 3.52\%$, weight gain $166 \pm 6.42\%$, SGR $1.63 \pm 0.04\%$) in 60 days and found significantly different ($P < 0.05$) from other diets. Protein efficiency ratio (0.33 ± 0.01) and lipid efficiency ratio (2.41 ± 0.02) were found to be significantly different ($P < 0.05$) among the diets. The broken line curve indicated optimum dietary protein in the range of 50-51 % and that of lipid in the range of 10-11 % for better growth of flowerhorn juveniles. Statistically significant difference ($P < 0.05$) was not observed in survival of fishes fed different diets. In the experiment II, juveniles of flowerhorn (average length = 4.6 ± 0.05 cm and weight = 1.91 ± 0.06 g) were fed different feeds such as diet formulated on the basis of result of experiment I (T₁), goat heart (T₂), commercial feed (T₃) and Spirulina incorporated diet (T₄). The better growth (length gain, weight gain, SGR) observed in juveniles fed diets T₁ and T₃ as compared to T₂ and T₄ over a period of 60 days. The survival of 100 % was observed in all the diets. It is concluded that diet (T₁) is better for rearing the juveniles of flowerhorn.

**Effect of different organic manures and light on the growth of cabomba,
Cabomba caroliniana a. Gray 1837**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. A. S. Gurav	Registration No.: FRRTM080163
Year of thesis submission: 2011	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

Present study was conducted to determine the role of different organic manures viz. raw cattle manure, poultry manure and vermicompost on the growth of *C. caroliniana* different light intensity.

Experiment I was conducted to study the role of different organic manures viz. cattle manure, poultry manure and vermicompost on the growth of *C. caroliniana* in 100 g capacity pot for 35 days. The plastic cups of 85 ml capacity (5.8 cm diameter) were filled with 40 g soil and sand mixture (3:2) up to 2 cm and 2.0 g dried manure was added and remaining space was filled with 60 g soil and sand mixture. These pots were planted with shoots (8-10 cm) of *C. caroliniana* and kept in plastic pools (1.2 m diameter) contained 450 L water for 35 days growth. The better growth was recorded in poultry manure. Significant difference ($P < 0.05$) was found among the treatments for water nitrate-nitrogen and nitrite-nitrogen and available nitrogen and organic carbon in soil.

Experiment II was carried out to standardize the dose of poultry manure viz. 3.0293 g pot⁻¹, 3.2111 g pot⁻¹, 3.3929 g pot⁻¹, 3.5747 g pot⁻¹, 3.7565 g pot⁻¹ and without poultry manure (control) was used for growth of *C. caroliniana*. The plantation procedure was adopted similar as experiment I. It was observed that 3.2111 g poultry manure per pot was good for growth of the plant for 35 days.

Experiment III was used for growing *C. caroliniana* under the different light intensity for 35 days. Different light intensity viz. 6100-8400, 34400-37000 and 47500-51600 lux were adjusted by covering planted plastic pools with different cloths and 91500-93500 lux without cover. During this study growing media with 3.2111 g poultry manure was used and plantation procedure was adopted similar as experiment I. Results indicated that better growth of plants with dark green colour of leaves was observed in plastic pool with 6100-8400 lux light intensity as compared with 34400-37000 and 47500-52000 lux light intensity and without covered pool. It is concluded that 100 g of growing media mixed with 3.2111 g poultry and with 6100-8400 lux light intensity showed better growth of *C. caroli*.

**BREEDING PERFORMANCE, LARVAL GROWTH AND SURVIVAL OF
MOLLY FISH, *POECILIA SPHENOPS* (VALENCIENNES, 1846)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. A. B. Durgude	Registration No.: FRRTM090175
Year of thesis submission: 2011	
Name of the research guide: Shri. D.I. Pathan	Designation: Assistant Professor

In the study, attempts were made to evaluate effects of stocking densities on breeding performance, larval growth and survival of *Poecilia sphenops*. In experiment I, brood fishes consisting males (Length - 4.2 to 4.6 cm, weight - 0.84 to 0.89 g) and females (Length - 5.3 to 5.6 cm, weight - 2.40 to 2.65 g) were stocked at the different densities of 50, 100, 150, 200 and 250 fishes m⁻² in cages with sex ratio of 4 females :

1 male for a period of 90 days. The fishes were fed semi-purified flake feed containing 39.48% crude protein at the rate of 8-10% of body weight day⁻¹. The average number of fry produced per tank was significantly ($P < 0.05$) higher at highest density of 250 brood fishes m⁻². The results indicated need for testing stocking densities higher than 250 brood fishes m⁻² for observation of fry production. However, the maximum number of fry produced per female (23.69) was recorded for brood fishes stocked at density of 50 fishes m⁻² and maximum survival (75%) was recorded for brood fishes stocked at density of 50, 100 and 200 fishes m⁻². The number of fry produced per female stocked at density of 50 fishes m⁻² was significantly better than that of fishes stocked at other densities which suggest to further investigate reproductive performance of females stocked at densities lower than 50 brood fishes m⁻².

In experiment II, *P. sphenops* fry with initial length in the range from 1.0 to 1.1 cm and initial weight ranging from 0.0575 to 0.0590 g were reared at four different stocking densities of 0.33 fry L⁻¹, 0.5 fry L⁻¹, 1.0 fry L⁻¹ and 2.0 fry L⁻¹ for a period of 60 days. The fry were fed semi-purified flake feed containing 39.48% crude protein at the rate of 10% body weight day⁻¹. The fry reared at densities of 0.33 and 0.5 fry L⁻¹ showed significantly ($P < 0.05$) better length gain and survival than those of fry reared at densities of 1.0 and 2.0 fry L⁻¹. The fry reared at density of 0.33 fry L⁻¹ showed significantly higher weight gain and specific growth rate than those of fry reared at other densities. The study revealed that a density of 250 brood fishes (4 females : 1 male) m⁻² in cage yielded highest fry production per tank and stocking density of 50 brood fishes (4 females : 1 male) m⁻² in cage yielded highest fry production per female over a duration of 90 days. Stocking density of 0.33 to 0.5 fry L⁻¹ resulted in better growth and survival of fry for a culture period of 60 days.

**Use of some anesthetics in transportation of angelfish, *pterophyllum scalare*
(Schultze, 1823)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. S. V. Jadhav	Registration No.: FRRTM090176
Year of thesis submission: 2011	
Name of the research guide: Shri. G. S. Ghode	Designation: Assistant Professor

The aim of the study was to examine the use of some anesthetics viz. eugenol, quinaldine and sodium bicarbonate for transportation of different size groups such as small (<3.5 cm), medium (3.5-4.5 cm) and large (>4.5 cm) size group of angelfish *Pterophyllum scalare*. For this study, effective concentrations and 96-h LC₅₀ values of selected anesthetics on different size groups were estimated.

Effective concentrations were decided on the basis of efficacy criteria of anesthetics for various size groups of angelfish *P. scalare*. The effective concentrations for small size groups found were eugenol (80 mg L⁻¹), quinaldine (25 mg L⁻¹) and sodium bicarbonate (40 g L⁻¹), for medium size groups were eugenol (85 mg L⁻¹), quinaldine (30 mg L⁻¹) and sodium bicarbonate (45 g L⁻¹) and for large size groups were eugenol (95 mg L⁻¹), quinaldine (40 mg L⁻¹) and sodium bicarbonate (55 mg L⁻¹).

The 96-h LC₅₀ values of selected anesthetics estimated for small size group of angelfish *P. scalare* were eugenol (21.373 mg L⁻¹), quinaldine (10.303 mg L⁻¹) and sodium bicarbonate (2469.549 mg L⁻¹), for medium size group values were eugenol (21.856 mg L⁻¹), quinaldine (10.758 mg L⁻¹) and sodium bicarbonate (2821.284 mg L⁻¹) and for large

size group values were eugenol (22.326 mg L⁻¹), quinaldine (11.720 mg L⁻¹) and sodium bicarbonate (3320.818 mg L⁻¹).

The estimated effective concentrations of three anesthetics were used for transportation of respective group. Small size group of angelfish *P. scalare* were anesthetized with eugenol (80 mg L⁻¹), quinaldine (25 mg L⁻¹) and sodium bicarbonate (40 g L⁻¹) and one control i.e. without anesthesia and transported for 42 hours by road. Maximum survival recorded in quinaldine (100%) was significantly different ($p < 0.05$) than survival recorded in sodium bicarbonate (68.57%) but there was no significant difference ($p > 0.05$) between survival recorded in quinaldine and eugenol (97.14%) as well as between quinaldine and control (88.57%). Medium size group of angelfish *P. scalare* were anesthetized with eugenol (85 mg L⁻¹), quinaldine (30 mg L⁻¹) and sodium bicarbonate (45 g L⁻¹) and one control i.e. without anesthesia. Maximum survival recorded in quinaldine (100%) was not significantly different ($p > 0.05$) than eugenol (98.57%), control (90.00%) and sodium bicarbonate (87.14%). Large size group of angelfish *P. scalare* were anesthetized with eugenol (95 mg L⁻¹), quinaldine (40 mg L⁻¹), sodium bicarbonate (55 mg L⁻¹) and one control without anesthesia. Maximum survival recorded in quinaldine (100%) was significantly different ($p < 0.05$) than control (80.00%) but not significantly different ($p > 0.05$) than eugenol (97.14%) and sodium bicarbonate (95.71%). Maximum survival recorded in quinaldine (100%) than other anesthetics at concentration of 25 mg L⁻¹, 30 mg L⁻¹ and 40 mg L⁻¹ for small, medium and large size groups of angelfish *P. scalare* respectively. From the observations of the present study, it may be concluded that anesthetic like quinaldine may be effectively used to reduce the pre-transportation stress of fishes.

**Growth and survival of angelfish, *Pterophyllum scalare* (schultze, 1823) fry
reared
at different stocking densities**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. P. A. Patil	Registration No.: FRRTM090178
Year of thesis submission: 2011	
Name of the research guide: Shri. R. M. Tibile	Designation: Assistant Professor

In the commercial ornamental fish culture, use of optimized stocking density, provision of nutritionally balanced feed with appropriate feeding strategy and maintenance of good water quality are important aspects in success of production and maintaining welfare of ornamental fish. During the present study, the effects of different stocking densities on the growth and survival of angelfish, *Pterophyllum scalare* fry reared in all-glass tanks with and without filtration system were evaluated.

In the experiment I, *P. scalare* fry in the range of 1.3-1.6 cm and 0.060-0.075 g were reared at different densities, i.e. 3 fry L⁻¹, 2 fry L⁻¹, 1 fry L⁻¹ and 0.5 fry L⁻¹ for a period of 45 days in all glass tanks (36 L) without undergravel filtration system. The fish fry were fed flake feed containing 49.02% crude protein and daily water exchange of 10-15% was done for each tank. The maximum average length gain (135.1060%), weight gain (945.7096%), specific growth rate (5.2162%) and survival (100%) were recorded for the fry reared at density of 0.5 individual L⁻¹ and found significantly better ($P < 0.05$) than the fry reared at other densities. In the study, growth and survival of *P. scalare* fry decreased with increase in stocking density.

In the experiment II, the best and higher stocking density obtained from the experiment I, i.e. 0.5 individual L⁻¹ was used as the lowest stocking density.

Accordingly, *P. scalare* fry in the range of 1.3-1.6 cm and 0.060-0.076 g were reared at different densities, i.e. 3 fry L⁻¹, 2 fry L⁻¹, 1 fry L⁻¹ and 0.5 fry L⁻¹ for a period of 45 days in all glass tanks (36 L) with undergravel filtration system. The freshwater was added to compensate evaporative water loss from the tanks, but no water exchange was carried out in the experimental tanks. Fry were fed flake feed containing 49.02% crude protein. The fry reared at the density of 0.5 fry L⁻¹ showed significantly ($P<0.05$) higher length gain (153.6593%), weight gain (967.5915%) and specific growth rate (5.2622%) than that of the fry reared at other densities. The densities of 0.5 and 0.1 fry L⁻¹ resulted in 100% survival which was found significantly better ($P<0.05$) than that of the fry reared at densities of 2 and 3 fry L⁻¹. The growth of fry was observed to be decreased with increase in the stocking density. In both the experiments, the observation on the water quality revealed that the dissolved oxygen values decreased with increase in stocking density. Whereas, the value of free CO₂, ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen increased with increase in stocking densities over the culture period.

The present investigation indicated that stocking density of 0.5 individual L⁻¹ showed better growth and survival of *P. scalare* fry reared for 45 days in all glass tanks without and with undergravel filtration system.

EFFECT OF DIFFERENT DIETARY PROTEIN LEVELS AND STOCKING DENSITIES ON GROWTH AND SURVIVAL OF JUVENILES OF OSCAR, *Astronotus ocellatus* (Agassiz, 1831)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Shri. Satish Tukaram
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Year of thesis submission: 2012

Name of the research guide: Dr. H. T. Dhaker

Designation: Head and Professor

Oscar, *Astronotus ocellatus*, is one of the popular and costly ornamental fishes. The fish has become popular among aquarium keepers due to its natural beauty. Two experiments were conducted to find out optimum stocking density and protein requirement in diet of the fish. In experiment I, the juveniles (length 1.4 ± 0.13 cm; weight 0.03 ± 0.004 g) were fed three diets such as 40, 50 and 60 % protein level in three stocking densities such as 0.2, 0.4, and 0.6 fish L⁻¹ (3, 6 and 9 fishes/tub) to form nine treatment viz. 40P3S as 40% protein and 3 fish / tub stocking density, 40P6S, 40P9S, 50P6S, 50P9S, 60P3S, 60P6S and 60P9S for period of 60 days. Among the experimental treatments, the treatment 50P3S showed significantly higher growth such as weight gain (6926.72 ± 19.63), specific growth rate (3.08 ± 0.03), and survival (88.89 ± 11.1). The feed utilization such as protein efficiency ratio (3.96 ± 0.14) was significantly higher than other treatments, where as feed conversion ratio (0.63 ± 0.02) significantly lower than other treatments. Condition factor (16.57 ± 5.52) was significantly higher than treatment 40P9S and 50P9S.

In experiments II, the juveniles (length 1.3 ± 0.03 cm; weight 0.23 ± 0.02 g) were fed four different diets such as goat heart, beef heart, commercial feed and specially designed diet (COF diet) for a period of 60 days. The commercial feed showed significantly higher weight gain (728.58 ± 3.69), specific growth rate (1.52 ± 0.06), protein efficiency ratio (2.21 ± 0.25) and the condition factor (6.40 ± 0.84) than goat heart and beef heart. However, COF diet did not significantly differ with growth

of commercial diet. The survival of juvenile *A. ocellatus* was not significantly different among the diets. The study indicated incorporation of 50% crude protein in diet and stocking the fishes at low density of 0.2 fish L⁻¹ found to be optimum for better growth, survival and feed utilization of juvenile *A. ocellatus*.

**REPRODUCTIVE PERFORMANCE OF WILD AND CULTURE POND
FEMALES OF GIANT FRESHWATER PRAWN, *Macrobrachium rosenbergii*
(De Man, 1879)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Imran I. Hundekari	Registration No.: FRRTM100183
Year of thesis submission: 2012	
Name of the research guide: Dr. A. S Pawase	Designation: Associate Professor

The giant freshwater prawn hatchery requires broodstock to be procured either from culture ponds or from natural sources like rivers, creeks, estuaries, reservoirs etc. The present study was undertaken to assess their comparative performance in terms of reproductive potential of females grown either in culture ponds or by wild stock collection. A reproductive output was tested using the parameters such as fecundity, eggs diameter, size of first zoea and proximate composition of eggs in various developmental stages. The brooders from pond environment were obtained from culture ponds of Jaysingpur, Kolhapur (District) while wild broodstock were collected from Juve creek and Madh reservoirs of Junnar of Pune district. Fecundity studies were carried out on 60 females, with an equal share from pond and wild sources. The results obtained in present work showed absolute fecundity to be higher in wild broodstock as compared to that of pond reared broodstock with regard to relative fecundity it was comparable. A significant difference was noticed in egg diameter of pond reared females during the progression in four developmental stages while it was uniform in wild prawns. However, the values were higher in wild as compared to pond reared ones. In the zoeal studies, the size of first zoea obtained from wild stock was higher as compared to pond reared ones. The proximate composition studies of eggs showed a significant higher value only in wild prawn eggs. Based on the results obtained in present study, it can be concluded that the hatchery owners are required to obtain wild female broodstocks for the purpose of cost effectiveness while operating a hatchery unit.

**EFFECT OF DIFFERENT FILTER MEDIA IN ARTIFICIAL SEAWATER
RECIRCULATION SYSTEM FOR LARVAL REARING OF *Macrobrachium*
rosenbergii (Deman, 1879)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Nikhil Subhash Sawant	Registration No.: FRRTM10085
Year of thesis submission: 2012	
Name of the research guide: D. I. Pathan	Designation: Associate Professor

The giant freshwater prawn culture is slowly gaining momentum in distantly located inland areas of the country. Seed production at larger scale near the inland

farming areas may prove to be beneficial to keep up the prawn farming development. Use of artificial seawater using proper filtration system may add to cost effectiveness for production of quality seed. In the present study, the attempt has been made to devise proper filtration technique using artificial seawater for production of *M. rosenbergii* postlarvae.

Performances of different filter media (T1 – coir + bamboo; T2 – perforated PVC pipe rings; T3- synthetic media) were tested in artificial seawater recirculation system by analyzing water quality parameters of larval rearing tanks. Coir and bamboo (T1) showed superior efficiency in removing nitrogenous wastes as well as in increasing nitrate production by maintaining the water quality parameters within the optimal range. Additionally, a survival of 21% with production of 12.6 PL L⁻¹ was achieved in T₁. In remaining treatments, the survival of 14%, 19% and 18% was obtained in T₀, T₂ and T₃ respectively. The post larvae production of 8.4 PL L⁻¹, 11.4 PL L⁻¹ and 10.8 PL L⁻¹ was achieved in T₀, T₂, and T₃ respectively. Based on the results obtained in the present study, it can be concluded that artificial seawater along with combination of filter media like Bamboo rings and coir can be effectively used for production of post larvae of *M. rosenbergii* in distantly located inland areas.

CAGE CULTURE OF STRIPED CATFISH, PANGASIANODON HYPOPHthalmus (SAUVAGE, 1878) IN RESERVOIRS

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Ghodke patil Rajesh Balkrishna	Registration No.: FRRTM 0110213
Year of thesis submission: 2014	
Name of the research guide: Dr. A.S.Pawase	Designation: Associate Professor

The growth and survival of striped catfish *Pangasianodon hypophthalmus* reared in cages and the nutrient status of cage water was analyzed in the present study. In the experiment I, the fingerling of striped catfish, *Pangasianodon hypophthalmus* were reared at stocking density of 125 fish m⁻³ in floating reservoir cages (6 x 4 x 4m) to study the growth and survival for a period of 210 days at Khandpe and Dhasai dam of Thane district of Maharashtra state. The average initial length and weight of *Pangasianodon hypophthalmus* stocked in cages at Khandpe dam was 3.4 ± 0.06 cm and 5.2 ± 0.08 g respectively whereas, at Dhasai dam, it was 3.3 ± 0.07 cm to 5.1 ± 0.06 g respectively. The final average length and weight of the *Pangasianodon hypophthalmus* was 34.2 ± 0.09cm and 745 ± 0.16g at Khandpe dam; whereas, 32.2 ± 0.06cm and 701 ± 0.10g at Dhasai dam respectively. The maximum specific growth rate at Khandpe and Dhasai dam was 7.53 % and 7.24 % respectively. The survival rate was 88 % at Khandpe dam and 80 % at Dhasai dam. The results revealed that there was no significant difference between growth and survival of *Pangasianodon hypophthalmus* reared in cages at Khandpe and Dhasai dam.

In the experiment II, the nutrient status of water in and around cages installed at Khandpe and Dhasai dam was analyzed. The water parameters were studied inside and outside of the cage (200m away from the cage). Results showed that water temperature at the site varied in the range of 25.3 to 34.8 °C at Khandpe dam and 25.4 to 35.8 °C at Dhasai dam. The water pH, total alkalinity, total hardness, nitrite, nitrate and phosphate were found to be slightly higher inside the cage when compared with that of outside the cage. Whereas, transparency and dissolved oxygen were found to

be at lower inside the cage than that of outside the cage. The study revealed that water in the cages tend to possess relatively higher amounts of nutrients. However, the present levels of cage culture activities do not seem to adversely affecting on surrounding environment at both selected sites.

CULTURE OF CHIRONOMID LARVAE (INSECTA-DIPTERA-CHIRONOMIDAE) USING ORGANIC MANURES AND SUBSTRATES

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Amol Arvind Shelke	Registration No.: FRRTM 0110215
Year of thesis submission: 2014	
Name of the research guide: Dr. D. I. Pathan	Designation: Assistant Professor

In the present study, culture of chironomid larvae was carried out using different organic manures and organic substrates.

Experiment I was conducted to study the effect of different organic manures *viz.* groundnut oil cake and chicken manure on production of chironomid larvae in culture condition using 50 lit capacity tub. Manures were applied at the rate of 100% GOC partially substituted by chicken manure @ 20%, 40%, 60%, 80% and 100% basis. The experiment was conducted for a period of 15 days with four replicates for each treatment following Completely Randomized Design (CRD). No significant difference was observed among the treatments for water parameters, while significant difference was observed in weight of *Chironomus striatipennis*. As per the results, application of chicken manure at the rate of 100% (T₅) recorded higher weight i.e. 7.54 ± 0.5075 g compared with remaining treatments such as T₀ (100% GOC), T₁ (80% GOC + 20% CM), T₂ (60% GOC + 40% CM), T₃ (40% GOC + 60% CM) and T₄ (20% GOC + 80% CM) having weight 3.01 ± 0.4575, 3.94 ± 0.4578, 4.92 ± 0.4372, 5.32 ± 0.3768 and 5.99 ± 0.4607 g respectively.

Experiment II was carried out to study the effect of different organic substrates on culture of chironomid larvae. Different organic substrates *viz.* Sugar Molasses, Banana leaves, Coconut leaves and Taro leaves were used and spread over culture tanks covering 50% water surface. Significant difference was observed in weight of *Chironomus striatipennis* while no significant difference was found among the treatments for water parameters. Tanks with taro leaves (T₄) recorded highest biomass of 9.92 ± 0.0494 g compared to remaining treatments such as T₀ (without substrate), T₁ (Sugar Molasses), T₂ (Banana leaves) and T₃ (Coconut leaves) having weight 5.22 ± 0.6017, 7.45 ± 0.6332, 8.39 ± 0.6486, 7.65 ± 0.5819 and 7.54 ± 0.5075 g respectively.

The floating substrate provided in Experiment II, acted as a platform for deposition of eggs as well as contributed to organic detritus for building tube. Provision of substrate had accelerated the density of tube as well as total biomass. In Experiment II, the total biomass was 9.92 ± 0.0494 g which was higher than 7.54 ± 0.5075 g in Experiment I.

On wet weight basis, proximate composition of *Chironomus striatipennis* contains moisture (87.10 ± 0.009%), crude protein (5.38 ± 0.003%), crude lipid (1.32 ± 0.003%), ash (1.63 ± 0.007%), fiber (1.01 ± 0.003%), nitrogen free extract (3.56 ± 0.009%) and gross energy (243.774 MJ kg⁻¹) while crude protein (41.73 ± 0.001%), crude lipid (10.23 ± 0.005%), ash (12.63 ± 0.004%), fiber (7.84 ± 0.002%), nitrogen

free extract ($27.57 \pm 0.005\%$) and gross energy ($1889.733 \text{ MJ kg}^{-1}$) was estimated on dry weight basis.

EFFECT OF RATION LEVEL ON GROWTH AND BODY COMPOSITION OF JUVENILE, *PANGASIANODON HYPOPHTHALMUS* (SAUVAGE, 1878)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shwetanshumala	Registration No.: FRRTM 0110216
Year of thesis submission: 2013	
Name of the research guide: Dr. H. T. Dhaker	Designation: Head and Professor

To investigate the growth feeding ration responses of juvenile *Pangasianodon hypophthalmus*, a 120 days trial was conducted in 15 plastic pools. Juvenile *P. hypophthalmus* weighing a mean of $1.2 \pm 0.01 \text{ g}$ were fed a diet (35% protein and 3% lipid) at different ration levels (4%, 6%, 8%, 10% and 12% of initial body weight per day for 60 days and then re-fed a diet (25% protein and 4% lipid) at normal ration for another 60 days ($P < 0.05$). At the end of the restricted-ration period, significant differences were found in growth. At the end of the experiment of different ration significant differences were found in length gain, weight gain, specific growth rate, feed conversion efficiency, protein efficiency ratio, lipid efficiency ratio, feed intake, voluntary feed intake. The relationship between specific growth rate a $\text{SGR}_w = 0.6380 + 0.4344\text{RL} - 0.0712\text{RL}^2$; $R^2 = 0.9272$ while $\text{FCE} = 0.8431 - 0.09785\text{RL} - 0.01933\text{RL}^2$; $R^2 = 0.9272$. The compensatory growth was also observed in *P. hypophthalmus*. Feed conversion efficiency decreased significantly with increasing ration levels. After 60 days of the normal ration period, there was significant difference in length gain, weight gain, specific growth rate, feed conversion efficiency, protein efficiency ratio, lipid efficiency ratio, feed intake, and voluntary feed intake of juvenile *P. hypophthalmus*. It may be concluded that a ration size between 8-12% of BW day^{-1} is better for growth and feed conversion efficiency of juvenile *P. hypophthalmus*. It also found that higher weight gain and specific growth rate after refeeding at normal ration was lower in the fish that had higher ration level. This indicate that the compensatory growth response in *P. hypophthalmus*.

INFLUENCE OF DIFFERENT STOCKING DENSITIES ON GROWTH AND SURVIVAL OF ANGELFISH, *PTEROPHYLLUM SCALARE* (SCHULTZE, 1823) JUVENILES

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Sawant Priyanka Bapu	Registration No.: FRRTM 0110217
Year of thesis submission: 2014	
Name of the research guide: Dr. A.S.Pawase	Designation: Associate Professor

Effect of various stocking densities was tested on the angelfish, *Pterophyllum scalare* in the present work. The HDPE circular tanks of 110 L capacity with and without undergravel filtration system was used for the experiments. Experimental duration was kept as 90 days for both the experiments. In the experiment I, the juveniles (length between 3.13 ± 0.0105 and $3.2075 \pm 0.0097 \text{ cm}$; weight between 0.5904 ± 0.0074 and $0.6005 \pm 0.0085 \text{ g}$) were stocked in the tanks devoid of undergravel filters at four different stocking densities of 0.2, 0.3, 0.4 and 0.5 individuals L^{-1} as T_1 , T_2 , T_3 and T_4 respectively for a period of 90 days. The fishes

were fed with flake feed and daily water exchange of 8-10 % was carried out for each tank. Stocking density of 0.2 individuals L⁻¹ (T₁) showed significantly higher growth in terms of average length gain 65.11%, average weight gain 415.89%, specific growth rate (1.82%) and survival (99%) which was found to be significantly higher ($P < 0.05$) than other densities of 0.3, 0.4 and 0.5 individuals L⁻¹.

In the experiment II, the stocking density of 0.2 individuals L⁻¹ as observed in the experiment I was set as a lower limit of treatments. The juveniles (length between 3.1933 ± 0.0106 and 3.2350 ± 0.0131 cm; weight between 0.5976 ± 0.0097 and 0.6243 ± 0.0096 g) were stocked in HDPE circular tanks with undergravel filtration system at four different stocking densities viz. 0.2, 0.3, 0.4 and 0.5 individuals L⁻¹ as T₁, T₂, T₃ and T₄ respectively for period of 90 days. The fishes were fed with flake feed. During the experiment, no water exchange was done but new water was added to the experimental tanks to compensate the evaporative water loss. Maximum average length gain (71.08%), weight gain (432.07%) and specific growth rate (1.86%) were observed with the stocking density of 0.2 individuals L⁻¹ (T₁) and found to be significantly higher ($P < 0.05$) than the densities of 0.3, 0.4 and 0.5 individuals L⁻¹. The density of 0.2 and 0.3 individuals L⁻¹ showed significantly higher survival (100% and 99.33% respectively) and found to be significantly higher ($P < 0.05$) than 0.4 and 0.5 individuals L⁻¹. The results revealed that stocking density had a significant effect on growth and survival rates of angelfish. Fish held at the highest density 0.5 individual L⁻¹ exhibited lowest growth rate and survival rates.

Rearing of angel fish, *Pterophyllum scalare* (schultze, 1823) from fry to fingerling using recirculatory water system

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Vidyarani Sandeepan
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Year of thesis submission: 2015

Name of the research guide: Dr. D. I. Pathan

Designation: Assistant Professor

Various studies have indicated inverse relation between stocking density and growth along with survival. Therefore, in the present study, an attempt was made to determine the highest possible stocking density, when better environmental conditions were provided by recirculating the water through biofilters and maintaining water parameter with tolerable limit.

The comparative study was conducted for 45 days period to investigate the effects of stocking density on the growth and survival of fry *Pterophyllum scalare* reared in FRP tanks having capacity of 110 L provided with recirculatory system and without recirculatory system. Fishes of average initial length 1.4 ± 0.010 cm and average weight 0.067 ± 0.001 g were stocked at three different stocking rates i.e. 1 individual L⁻¹, 1.5 individual L⁻¹ and 2 individual L⁻¹ in all treatments. Fishes were fed with flake feed containing 49 % of crude protein.

Treatment tanks i.e. 1 individuals L⁻¹ (FT₁), 1.5 individuals L⁻¹ (FT₂) and 2 individuals L⁻¹ (FT₃) were provided with biofilter for recirculation of the water. The discharge end of tanks was connected to inlet of canister filters containing four different filter media in different chamber, i.e. Polywool, Activated charcoal, Bamboo rings with coir and Oysters shell. Similar stocking density i.e. 1 individual L⁻¹ (CT₁), 1.5 individual L⁻¹ (CT₂) and 2 individual L⁻¹ (CT₃), was maintained in FRP tank

without provision of filter. Water exchange was carried out at the rate 10-15%, daily. These tanks were designated as control for comparative analysis.

As per the results, at the end of experiment, the ammonia values 0.080 (CT₁), 0.100 (CT₂) and 0.118 (CT₃) were observed in control group. The nitrite values in same group were 0.083 (CT₁), 0.132 (CT₂) and 0.181(CT₃).Comparatively, lower values of ammonia i.e. values 0.030 (FT₁), 0.027 (FT₂), 0.036 (FT₃) and nitrite 0.032 (FT₁),0.029 (FT₂) and 0.055 (FT₃) were observed. There values were tolerable limits as per Ayyappan (2011). The results proved the effectiveness of biofilter in recirculatory system.

To estimate the highest possible stocking density in recirculatory system, comparative analysis of growth parameter such as length gain, weight gain, specific growth rate and survival was carried out among the treatments provided with biofilter i.e FT₁, FT₂ and FT₃. Among these treatment, highest length gain (164.28%), weight gain (1110%), specific growth rate(5.541%) and survival (96.66) was observed in stocking density 1.5 L⁻¹.

Effect of some minerals in shell hardening of mud crab, *Scylla serrata* (forskal, 1775)

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Sachin Kurkute

Registration No.: FRRTM0120243

Year of thesis submission: 2014

Name of the research guide: Dr. A. S. Pawase

Designation: Associate Professor

Mud crabs (*Scylla serrata*) are considered as delicacy in local as well as international markets due to their meat protein quality and nutritional value. In India, the importance of live mud crabs as an export commodity has opened up great opportunities for crab farming. Mud crab aquaculture has been practiced for many years in India, based primarily on capture and fattening of juvenile crabs from the wild. In India, traditionally, mud crabs fattening and culture practices are mostly carried out in cages, pens and ponds. During fattening, the mud crabs invariably require three to four weeks duration for shell hardening. The soft crabs are required to get harden in order to get good price from the crab traders. The soft crabs tend to absorb minerals from water in postmoult stage for the shell hardening. In the present study, effect of some minerals dissolved in water was tested on soft crabs in an attempt to reduce the period of shell hardening.

In the experiment I, Mud crab juveniles in the initial size range of 73 - 94 mm and in the weight range of 110-160 g were used. Mud crabs in premoult stage were stocked in water of various minerals concentrations using different combinations of CaCO₃, MgSO₄, KCl in seawater of around 25 ppt salinity. The results indicated the minimum hardening period of 9±0 days in T₁₃ having the mineral concentration of CaCO₃-800mgL⁻¹, MgSO₄-1700mgL⁻¹ and KCl-800mgL⁻¹. The hardening period in T₁₃ was significantly higher ($P < 0.05$) than that of other treatments containing minerals media at different levels.

The experiment II, evinced minimum duration of shell hardening of 9 ±0.58 days observed in T₁ (CaCO₃-800 mgL⁻¹+MgSO₄-1700 mgL⁻¹ + KCl-800 mgL⁻¹) and 9 ±0.58 days in T₁₂ (CaCO₃ -1000mgL⁻¹+ KCl -1000mgL⁻¹) followed by 9.17 ±0.31days in T₂ (CaCO₃ - 800mgL⁻¹+ MgSO₄ - 1700mgL⁻¹) ,9.5±0.41days in T₁₃ (CaCO₃ - 1100mgL⁻¹ +MgSO₄-2000 mgL⁻¹ + KCl-1100 mgL⁻¹) , 9.5±0.41 days in T₁₆ (CaCO₃- 1100 mgL⁻¹+ KCl-1100 mgL⁻¹), 9.67± 0.71 days in T₁₅ (MgSO₄-2000 mgL⁻¹ + KCl-

1100 mgL⁻¹), 9.67± 0.83 days in T₁₀ (CaCO₃-1000 mgL⁻¹+ MgSO₄-1900 mgL⁻¹) and 9.67± 0.31 days in T₇ (MgSO₄-1800 mgL⁻¹ + KCl-900 mgL⁻¹). Treatment T₁ and T₁₂ differed significantly (*P*<0.05) and evinced the least hardening period of 9 ±0.58 days. The present study would be useful for crab farmers to decrease the cost of maintenance of soft crab by decreasing the duration of hardening.

EFFECT OF HORMONES INCORPORATED FEEDS ON GROWTH AND SURVIVAL OF FLOWERHORN FISH

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Shri. Manoj Uttam Mane	Registration No.: FRRTM100209
Year of thesis submission: 2012	
Name of the research guide: D. I. Pathan	Designation: Associate Professor

The present study was undertaken to assess the effect of various hormones viz. 17 α -methyltestosterone (MT), Testosterone propionate (androgenic steroids), 19-Norethisterone (synthetic androgen), Thyroxin (liposoluble hormone) and Human chorionic Gonadotropin (Gynogenic steroid) on growth and survival of commercially important exotic ornamental fish, Flowerhorn. It is a crossbred between *Cichlasoma trimaculatum* and other cichlid species. It is one of the most popular fish among aquarium keepers due to its natural beauty and its ability to grow in a wide range of environmental condition. Flowerhorn males have vibrant colours and are more preferred by consumers than females.

In the Experiment I, observations were made on growth and survival of juveniles of flowerhorn (3.21 ± 0.05 cm of initial total length and 0.51 ± 0.03 g of initial total body weight) fed with fifteen different hormone incorporated diets such as, **T1** (MT 1.0 mg kg⁻¹), **T2** (MT 1.2 mg kg⁻¹), **T3** (MT 1.4 mg kg⁻¹), **T4** (TP 2.0 mg kg⁻¹) **T5** (TP 3.0 mg kg⁻¹), **T6** (TP 4.0 mg kg⁻¹), **T7** (TH 2.5 mg kg⁻¹), **T8** (TH 5.0 mg kg⁻¹), **T9** (TH 7.5 mg kg⁻¹), **T10** (NT 0.5 mg kg⁻¹), **T11** (NT 0.75 mg kg⁻¹), **T12** (NT 1.0 mg kg⁻¹), **T13** (HCG 10.0 mg kg⁻¹) **T14** (HCG 15.0 mg kg⁻¹), **T15** (HCG 20.0 mg kg⁻¹) for rearing period of 60 days. Among the various test diets, maximum length gain 81.53 ± 6.64%, weight gain 738.10 ± 4.05% and SGR 3.54 ± 0.13% was recorded in **T13** while highest survival (98.35 ± 1.67%) noted in **T7**.

In the Experiment II, observations were recorded on growth and survival of juveniles of flowerhorn (3.12 ± 0.04 cm of initial total length and 0.59 ± 0.03 g of initial total body weight) fed different diets viz, Best diet from experiment I with Human Chronic Gonadotropin (10.0 mg kg⁻¹) hormone (**T1**), Commercial feed I (**T2**) VII and Commercial feed II (**T3**). The juveniles of flowerhorn fed with **T1** diet (HCG 10.0 mg kg⁻¹) showed better growth (length gain 99.04 ± 2.59%, weight gain 357.77 ± 20.47% and SGR 3.63 ± 0.05%) and survival (96.35 ± 0.65%) during rearing period of 60 days.

EFFECT OF DIETARY LIPID SOURCES ON GROWTH AND SURVIVAL OF JUVENILES OF OSCAR, *Astronotus ocellatus* (Agassiz, 1831)

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Shri. Sharad Shantaram Pawar	Registration No.: FRRTM100210
Year of thesis submission: 2012	
Name of the research guide: H. T. Dhaker	Designation: Professor and Head

Oscar, *Astronotus ocellatus*, is one of the popular costly ornamental fish. Two experiments were conducted to study effect of different oil sources and level of lipid on growth, survival and feed utilization of juveniles of *A. ocellatus*. In experiment I, the juveniles (length 1.8 ± 0.04 cm; weight 0.03 ± 0.01 g) were fed six isoenergetic and isonitrogenous diets viz., sardine oil + linseed oil (T₁), sardine oil+ soyabean oil (T₂), sardine oil+ mustard oil(T₃), cod liver oil+ linseed oil (T₄), cod liver oil+ soybean oil(T₅) and cod liver oil + mustard oil(T₆) for period of 60 days. The experiment was designed as per completely randomized design with four replicates for each combination of oil sources. Among the experimental diets, the diet incorporated with sardine oil+ mustard oil showed significantly higher growth such as, length gain (20.25 ± 0.11), weight gain (440.96 ± 0.14) and specific growth rate (2.80 ± 0.04) and survival. The feed utilization such as protein efficiency ratio (20.04 ± 0.61) and lipid efficiency ratio (114.53 ± 0.35) were significantly higher than other diets, whereas feed conversion ratio (0.13 ± 0.01) significantly lower than other diets.

In experiment II, the juvenile (Length 1.9 ± 0.01 cm; weight 0.37 ± 0.01 g) were fed six diets with varying dietary lipid levels of 5, 7, 9, 11, 13, and 15% coded as T₁, T₂, T₃, T₄, T₅, and T₆ respectively for a period of 60 days. Whereas, the dietary lipid source were used as sardine+ mustard oil at 1:1 (w/w) proportion. The 7% lipid level showed significantly higher length gain (89.42 ± 0.60), weight gain (344.04 ± 0.25), specific growth rate (2.5 ± 0.03) lipid efficiency ratio (10.2 ± 0.19) and lower feed conversion ratio (1.0 ± 0.02). The survival of juveniles *A. ocellatus* did not differ significantly among the diets. The second order polynomial regression analysis showed 9% lipid optimal level for the growth and survival of juvenile of *A. ocellatus*. The study indicated incorporation of sardine oil + mustard oil as dietary source at 7 to 9% level for better growth, survival and feed utilization of juvenile *A. ocellatus*.

EFFECT OF SOME ACIDIFIERS ON GROWTH AND SURVIVAL OF *CATLA CATLA* (HAMILTON, 1822) FRY

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Supriya Bhivagade	Registration No.: FRRTM0110225
Year of thesis submission: 2014	
Name of the research guide: Dr. A. S. Pawase	Designation: Associate Professor

Effect of some acidifiers on growth and survival of catla spawn in the present work, the circular plastic tubs of 50 L capacity were used for experiment. Experimental duration was 15 days.

In experiment I, the catla spawn (length 6 ± 0.01 mm and weight 0.05 ± 0.03 g) stocked in the circular plastic tubs with stocking density (100 spawn / tub) for a period of 15 days. The spawn were fed with flake feed and daily water exchange of 8 -10 % was carried out for each tub. Sodium benzoate at 2% level showed higher growth in terms of average length gain 200 %, average weight gain 260 %, specific growth rate 8.539 %, survival 89.5 %, protein efficiency ratio 6.68 %, feed efficiency

ratio 0.90 % which was found to be significantly higher ($P < 0.05$) than other acidifiers level.

In experiment II, sodium benzoate at 2 % level observed best in experiment I. Hence this acidifier used in experiment II catla fry (length 2.56 ± 0.09 cm and weight 0.60 ± 0.07 g) were stocked in high density polyethylene (HDPE) circular tanks at stocking density 30 fry /tank for a period of 90 days. The fry were fed with flake feed and daily water exchange 15-20 % was carried out for each tank. Maximum length gain (59.21 %), weight gain (62.84 %) and specific growth rate (1.47 %), survival (84.99 %) and feed utilization protein efficiency ratio (2.64 %), feed efficiency ratio (0.63 %) were observed at 3 % level in 90 days. 3% level found to be significantly higher ($P < 0.05$) than other levels.

Results revealed that acidifiers level at 2 % in experiment I, and 3% in experiment II had significant effect on catla spawn and fry.

EFFECT OF DIETARY INCLUSION OF *MANGIFERA INDICA* AND *CARICA PAPAYA* ON GROWTH AND COLOURATION OF JUVENILE *CARASSIUS AURATUS* (LINNAEUS, 1758)

Degree: M.F.Sc.

Subject: Fish Nutrition and Feed Technology

Name of the Student: Janu Panyang

Registration No.: FRRTM0110226

Year of thesis submission: 2013

Name of the research guide: Dr. H. T. Dhakar

Designation: Head and Professor

Goldfish, *Carassius auratus* is the most popular variety of ornamental fish (NRE 2002). Besides body shape, fin shape, and size, an important characteristic affecting the market price of goldfish is body color. During the present research studies were conducted to study the effect of diets on colouration, growth and survival of juvenile goldfish, *C. auratus*. In experiment I, the juveniles (Length 3.2 ± 0.01 cm; Weight 0.76 ± 0.02 g) were fed six isoenergetic and isonitrogenous diets supplemented with 5% mango (T₁), 10% mango (T₂), 15% mango (T₃), 5% papaya (T₄), 10% papaya (T₅) and 15% papaya (T₆) in basal diet for a period of 60 days. The experiment was designed as per completely randomize design with three replicates for each treatment. Diets incorporated with 5% Papaya (T₄) showed significantly higher colouration ($12.64 \pm 0.14 \mu\text{g g}^{-1}$), growth (length gain $132.66 \pm 0.06\%$, weight gain $479.96 \pm 0.06\%$), specific growth rate (2.92 ± 0.10) and survival while 5 and 10% mango diets are showed better result.

In experiment, II the juveniles (Length 4.1 ± 0.03 cm; Weight 1.57 ± 0.01 g) were fed five diets incorporated with the mixture of 25 % papaya + 75 % mango, 50% papaya + 50% mango, 75 % papaya + 25 % mango, 100 % papaya and 100% mango in basal diet as T₁, T₂, T₃, T₄ and T₅, respectively for 60 days. The diet 75% papaya + 25 % mango level showed significantly higher colouration ($8.73 \pm 0.20 \mu\text{g g}^{-1}$), growth(length gain $86.66 \pm 0.14\%$, weight gain $227.63 \pm 0.61\%$, specific growth rate 1.97 ± 0.16). The study indicated the diet incorporated with 5% Papaya and 5-10 % mango while diet contains the mixture of 75% papaya + 25 % mango showed better growth, colouration and survival of juvenile *C. auratus*.

**EFFECT OF SUPPLEMENTATION OF DIETARY BAMBOO CHARCOAL
ON GROWTH PERFORMANCE OF *CARASSIUS AURATUS* (LINNAEUS,
1758)**

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Ashvini Balaji Patil	Registration No.: FRRTM0110227
Year of thesis submission: 2014	
Name of the research guide: Dr. D. I. Pathan	Designation: Associate Professor

The present study was undertaken to assess the effect of supplementation of dietary bamboo charcoal in feed on growth performance of *Carassius auratus*. Goldfish is the most admired ornamental fish throughout the world and also in India (Gupta and Banerjee, 2009). It is one of the most popular fishes among aquarium keepers due to its natural beauty. Two experiments were conducted to evaluate the effect of supplementation of dietary bamboo charcoal in feed on growth and survival in diet of the fish.

In the experiment I, the fry length (4.06 ± 0.05 cm) and weight (4.30 ± 0.26 g) were fed practical basal diet (40% crude protein) in the form of flakes during rearing period of 90 days. The bamboo charcoal powder was incorporated in the basal diet at various levels such as T₁, T₂, T₃, T₄, T₅ and T₆ to formulate six different test diets. Basal diet, without incorporation of bamboo charcoal powder, was used as control diet (T₀). Among the experimental treatments, the treatment T₃ showed significantly higher growth such as length gain ($248.69 \pm 3.01\%$), weight gain ($355.61 \pm 1.04\%$), specific growth rate (1.69%) and survival (98.9%). The feed utilization such as feed conversion ratio ($1.66 \pm 0.05\%$) was significantly lower in T₃ than control group, whereas feed efficiency ratio ($0.60 \pm 0.13\%$) and protein efficiency ratio ($3.15 \pm 0.03\%$) in T₃ showed significantly higher than that of other treatments. Carcass composition such as moisture ($70.11 \pm 0.061\%$), protein ($8.43 \pm 0.007\%$), lipid ($1.97 \pm 0.04\%$), ash ($2.33 \pm 0.5\%$), fiber ($2.07 \pm 0.09\%$) and Nitrogen free extract ($14.19 \pm 0.12\%$) was found better results in T₃ during rearing period of 90 days.

In the Experiment II, observations were recorded on growth and survival of juveniles of goldfish (4.34 ± 0.73 cm) of initial length and (4.07 ± 0.43 g) of initial weight fed different diets. As per the results of Experiment I, the diets with incorporation of 0.5, 0.75 and 1.25% bamboo charcoal powder in the diet indicated better results. Therefore, these three levels designated as T₁, T₂ and T₃ respectively were used in the diets for rearing of goldfish in the Experiment II along with control diet. The diets with level of bamboo charcoal powder 0.75% showed significantly higher length gain ($34.10 \pm 0.05\%$), weight gain ($42.37 \pm 2.01\%$), specific growth rate (0.40%) and survival (97.78%) than other treatments. Feed utilization such as feed conversion ratio (0.98 ± 0.05) was significantly lower in 0.75%, whereas feed efficiency ratio (1.02 ± 0.67) and protein efficiency ratio (1.37 ± 0.27) in T₂ showed significantly higher than that of other treatments. Carcass composition such as moisture ($70.88 \pm 0.17\%$), protein ($8.42 \pm 0.02\%$), lipid ($1.96 \pm 0.09\%$), ash ($2.38 \pm 0.08\%$), fiber ($2.14 \pm 0.02\%$) and Nitrogen free extract ($13.09 \pm 0.05\%$) noticed significantly better results in T₂ during rearing period of 45 days. The study indicated that flake feed with 40% crude protein incorporated with 0.75% of bamboo charcoal powder, was found to be optimum for better growth, survival and feed utilization of goldfish *Carassius auratus*

EFFECT OF SOME CAROTENOID SOURCES ON PIGMENTATION OF JUVENILE FLOWERHORN FISH

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Ayesha Shaikh	Registration No.: FRRTM0120254
Year of thesis submission: 2014	
Name of the research guide: Dr. H. T. Dhakar	Designation: Head and Professor

This study was conducted to evaluate the effect of diets containing different natural carotenoid sources such as marigold petal powder, rose petal powder, Spirulina powder and spinach leaves powder on the growth, survival and pigmentation of juvenile flowerhorn fish, with average initial size of 3.25 ± 0.01 cm and initial weight of 1.67 ± 0.01 g for a rearing period of 60 days. The growth, survival and pigmentation of juvenile flowerhorn fish increased significantly with the diet containing spinach.

The present study was also conducted to evaluate the effect of diets containing spinach at 100, 150 and 200 g/kg of basal diet on growth, survival and pigmentation of juvenile flowerhorn fish with average initial size 3.01 ± 0.01 cm and initial weight 1.64 ± 0.01 g for a rearing period of 45 days. Significant difference was observed in the growth, survival and pigmentation of juvenile flowerhorn fish. The present result demonstrated that spinach can be successfully used as a natural carotenoid source in juvenile flowerhorn fish. Our study also indicates that spinach at 200 g/kg in the basal diet is a suitable dietary level to ensure the better pigmentation, growth and survival in juvenile flowerhorn fish.

GROWTH AND SURVIVAL OF CATLA CATLA (HAMILTON, 1822) FRY USING EXOGENOUS CARBOHYDRATES

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Vrushali Patil	Registration No.: FRRTM0120253
Year of thesis submission: 2014	
Name of the research guide: Dr. A. S. Pawase	Designation: Associate Professor

Catla catla is one of the most important commercial fish in India with a maximum market demand and acceptability as food by the consumers due to its taste and flesh. The traditional culture of this fish involves supplemental feeding comprising a mixture of rice bran and oilcake (1:1) which is mostly employed in powder form. Due to the increased cost and limited availability of fish meal, researchers are looking forward to the plant-based ingredients to replace the fish meal in the future. However, plant cells are strengthened by cell walls that are mainly indigestible to vertebrate enzymes. But with the inclusion of enzymes in fish diets can be an alternative to improve the digestion and utilization of nutrients coming from plant ingredients. Also, there is limited information available on the use of feed enzymes in the supplementary feed of Indian major carps (IMCs). Thus, the present study was undertaken to investigate the effect of use of exogenous enzymes in improving the nutritional quality of practical feed of Catla fry, mainly groundnut oil cake (GNOC) and rice bran, and their influence on the growth and survival of fry.

In the present study, exogenous enzymes such as cellulase, hemicellulases and alpha-amylase were incorporated in diet at 0.5%, 1%, 1.5% level in different combinations. Catla fry in the initial size range of 17-19 mm and in the weight range of 0.37-0.45 g was used for a period of 90 days. Maximum final length gain of 171.91%, weight gain of 1088.22%, specific growth rate of 2.750%, survival 83.33%

and feed efficiency ratio of 0.3813%, were observed at 1.5% level of diet. The 1% level evinced also show maximum feed efficiency ratio of 0.3926 but was not significantly different to 1.5% level 0.3813. The growth response in the diet containing exogenous enzymes at 1.5% level was found significantly higher ($p < 0.05$) than that other diet containing exogenous enzymes at different levels. The present study indicated that the exogenous enzyme mixture consisting of cellulose, hemicelluloses and alpha-amylase incorporated at 1.5% level in the basal diet consisting of GNOC and rice bran was found to be most suitable for growth, survival and feed efficiency ratio of fry of *Catla catla*, respectively.

**EFFECT OF DIFFERENT LIPID SOURCES AND LEVELS ON
REPRODUCTIVE PERFORMANCE OF ZEBRA DANIO, *DANIO RERIO*
(HAMILTON, 1822)**

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Sachin narwade	Registration No.: FRRTM0130275
Year of thesis submission: 2015	
Name of the research guide: Dr. A. S. Pawase	Designation: Associate Professor

The Zebra danio, *Danio rerio*, an excellent beginner's aquarium fish of community aquaria, is also used in many fields of science including human diseases. In the present study, effect of broodstock diet on the fish was analyzed using various sources and levels of lipids. Sub adults of fishes in the size range of 34 to 36 mm were used for both the experiments.

In the Experiment I, various lipid sources such as cod liver oil + corn oil (CL+CO), cod liver oil + soybean oil (CL+SBO), cod liver oil + sunflower oil (CL+SO), cod liver oil + linseed oil (CL+LO) and cod liver oil (CL) at 13% level of lipid were incorporated in the broodstock diet. The reproductive performance of fishes was tested after every ten days over a period of 30 days. The results of this study showed that the reproductive performance in terms of fecundity, fertilization rate and hatching rate were ranged between 208.68 to 290.09 no. eggs g body weight⁻¹, 81.18 to 81.99 % and 67.77 to 83.02%, respectively for all the diets. A diet comprising cod liver oil + corn oil (CL+CO) with a level of 13% showed the best reproductive performance in terms fecundity, fertilization rate and hatching rate as 290.09 ± 20.46 no. eggs g body weight⁻¹, 90.49 ± 1.34% and 83.02 ± 0.80%, respectively and its performance was statistically significant ($P < 0.05$) from the remaining treatments.

On the basis of Experiment I, a diet comprising cod liver oil + corn oil at the level of 9, 11, 13, 15 and 17% were used in the Experiment II to find out requirement of optimum level of lipid in broodstock diet. The reproductive performance in terms of fecundity, fertilization rate hatching rate were ranged between 228.32 to 290.87 no. eggs g body weight⁻¹, 82.73 to 91.22 % and 73.18 to 85.03%, respectively the treatment T4 (15% of lipid) differed significantly ($P < 0.05$) and evinced the best reproductive performance in terms of fecundity (290 ± 12.16 no. eggs g body weight⁻¹), fertilization rate (91.22 ± 0.51%) and hatching rate (85.02 ± 2.61%).

It can be concluded that a broodstock diet containing cod liver oil + corn oil as lipid sources with a level of 15% can be used in broodstock diet of *Danio rerio*.

**CAGE REARING OF FRY TO FINGERLINGS OF *Cyprinus carpio* var.
communis (LINNAEUS, 1758) IN TELEWAEI RESERVOIR, RATNAGIRI**

Degree: M.F.Sc.	Subject: Aquaculture
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Name of the Student: Deshpande
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Registration No.: FRRTM0140288

Year of thesis submission: 2016

Name of the research guide: Dr. D. I. Pathan
Designation: Professor

The present study was undertaken to assess the effect of different stocking densities on growth and survival of *Cyprinus carpio var. communes* reared in floating cages installed in Telewadi Reservoir of Ratnagiri, Maharashtra. Fry with initial length range of 1.8 to 2.3 cm and initial weight range of 0.6 to 0.9 g were used for the experiment. The fry were stocked at five different densities viz: 1000 (T1), 1500 (T2), 2000 (T3), 2500 (T4) and 3000 (T5) fry m⁻³ in cages (dimensions of 1 x 1 x 1.5m) and reared for 60 days. Mixture of GOC and rice bran (1:1), along with mineral mixture (2%) was fed at the rate 5% and 5% of the body weight for first 1-30 days and 31-60 days, respectively. At the end of the experiment length gain (%) of 302.98 ± 19.65%, 338.07 ± 1.91%, 241.43 ± 13.75%, 201.80 ± 7.09% and 178.79 ± 9.7% were recorded in T1, T2, T3, T4 and T5, respectively. Similarly, the weight gain (%) recorded were 1530.36 ± 111.13%, 1755.72 ± 68.61%, 1283 ± 87.77%, 1169.80 ± 40.82% and 967.08 ± 27.37% were recorded in T1, T2, T3, T4 and T5, respectively. The specific growth rates recorded were 3.005 ± 0.12, 3.07 ± 0.06, 2.69 ± 0.09, 2.59 ± 0.04 and 2.42 ± 0.04 in T1, T2, T3, T4 and T5, respectively. At the end of the experiment, survival (%) were 81.22 ± 0.58%, 87.11 ± 1.25%, 57.5 ± 2.39%, 49.31 ± 1.73% and 38.46 ± 2.34% in T1, T2, T3, T4 and T5, respectively. The feed conversion ratio (FCR) values were 1.19 ± 0.05%, 1.08 ± 0.02%, 1.72 ± 0.08%, 1.88 ± 0.07% and 2.68 ± 0.09% in T1, T2, T3, T4 and T5, respectively. During the experimental period, the water temperature, pH, dissolved oxygen, total hardness and total alkalinity were varied from 23 to 27, 6.3 to 8.1, 3.8 to 6.2 mg L⁻¹, 80 to 95 mg L⁻¹, 63 to 89 mg L⁻¹. Highest length gain, weight gain and survival 338.07 ± 1.91 %, 1755 ± 68.61 %, and 87.11 ± 1.25 ± were recorded in T2 i.e., 1500 fry IT1-3 respectively

**EFFECT OF DIFFERENT DIETARY PROTEIN LEVELS ON
GROWTH, FEED CONVERSION AND BODY COMPOSITION OF
JUVENILE CARB *Scylla serrata* (Forsk., 1775)**

Degree: M.F.Sc.

Subject: Fish Nutrition and Feed
Technology

Name of the Student: Markad Prashant
Babasaheb

Registration No.: FRRTM0130289

Year of thesis submission: 2016

Name of the research guide: Dr. D. I. Pathan
Designation: Professor (CAS)

Mud crab culture is a fast growing industry in Asia owing to increasing global demand for live, frozen and soft-shelled crab. During crab culture, appropriate supply of amino acids is a pre-requisite for better growth (Lim., 1996). Therefore, the present study was undertaken to assess the effect of different dietary protein levels on growth, feed conversion and body composition of juvenile mud crab *Scylla serrata*. Crabs juveniles were obtained from local crab collectors and were acclimatized to laboratory conditions. The juveniles were stocked at a rate of one crab in each circular HDPE tank of 0.24 m² area with a water level of 4-5 cm. Totally, five semi-purified pelleted diets containing variable protein levels: 38 (T1), 40 (T2), 42 (T3), 44 (T4) and 46% (T5) but with a constant level lipid (8%) were prepared. The rearing experiment was

conducted for a period of 90 days with four replicates for each protein level following CRD. Mud crab juveniles having initial length in the range of 4.05 ± 0.06 to 4.30 ± 0.04 cm and initial weight in the range 39 ± 0.67 to 42.50 ± 0.51 g were selected for experiment by using 10 — 6% feeding ration. At the end of the experiment, T3 showed significantly higher growth in terms of length gain $118.69 \pm 3.84\%$, weight gain $236.61 \pm 10.76\%$, specific growth rate $0.80 \pm 0.03\%$ and average daily growth $89.79 \pm 2.95\%$ ($P < 0.05$). Among the treatments, the feed conversion ratio (0.24 ± 0.01) and the protein efficiency ratio (0.8 ± 0.01) were significantly better in T3. At the end of experiment, the crabs belonging to T3 recorded higher values of protein ($11.59 \pm 0.20\%$) and lipid ($3.6 \pm 0.07\%$) as compared to the crabs in other treatments ($P < 0.05$). Thus, considering crab growth, feed conversion and body composition parameters, pelleted feed containing 42% crude protein and 8% lipid was found to be most suitable diet for better growth and feed utilization for juvenile of *Scylla serrata*.

PRODUCTION OF FINGERLING OF *Catla catla* (Hamilton, 1822) USING CAGE CULTURE TECHNOLOGY IN RESERVOIR

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Rahul Pralhad Rathod	Registration No.: FRRTM0140290
Year of thesis submission: 2016	
Name of the research guide: Dr. B.R. Chavan	Designation: Professor

In recent years, culture of Indian major carps in reservoir, lake, tanks and ponds is gaining lot of momentum in India, but the availability of good quality fish fingerling is the major constraints. The present study therefore was undertaken with an objective to determine the effect of different stocking densities on growth and survival of rearing fry to fingerling of *Catla catla* in floating cages in reservoir. The experiment of different stocking density was carried out using freshwater fish, *Catla catla* fry in Kadwai reservoir of Ratnagiri (district), Maharashtra, India during September to November 2015. In this experiment, the observations were taken on growth performance (length gain, weight gain, and specific growth rate), survival, and water quality parameter such as temperature, pH, dissolved oxygen, total alkalinity, total hardness, transparency and primary productivity during the rearing period of 60 days.

The fry of catla were reared at five different densities 1000, 1500, 2000, 2500 and 3000 fry m^{-3} in floating cages ($1m \times 1m \times 1m$). Fry having an initial mean length and weight of 2.05 ± 0.06 cm and 0.80 ± 0.05 g were stocked at a rate of 1000 fry (T_1), 1500 fry (T_2), 2000 fry (T_3), 2500 fry (T_4), and 3000 fry (T_5) m^{-3} , they were fed with GOC, rice bran (1:1), and mineral mixture (2%) at a rate of 30% of the body weight for first 30 days. The feeding was reduced at a rate of 20% of the body weight for later 30 days of experiment. The final mean length and weight were 9.37 ± 0.15 , 8.62 ± 0.06 , 8.02 ± 0.04 , 7.72 ± 0.04 , 7.20 ± 0.04 cm and 9.55 ± 0.22 , 8.0 ± 0.05 , 7.52 ± 0.08 , 7.27 ± 0.36 , 6.57 ± 0.34 g. The specific growth rate were 2.44 ± 0.04 , 2.42 ± 0.04 , 2.38 ± 0.11 , 2.24 ± 0.10 , and 2.09 ± 0.04 % and survival were 63.97 ± 1.31 , 54.85 ± 0.59 , 49.55 ± 0.27 , 42.07 ± 1.05 , and 36.46 ± 0.82 % respectively at a stocking density of 1000, 1500, 2000, 2500, and 3000 fry m^{-3} . The maximum average length and weight values of 9.37 ± 0.15 cm and 9.55 ± 0.22 g and maximum production of fingerling of catla observed in lower stocking density of 1000 fry m^{-3} . The minimum average length and weight values of 7.20 ± 0.04 cm and 6.57 ± 0.34 g, and minimum average production of 1094 nos and 36.46 ± 0.82 % survival of fingerling of catla

observed in 3000 fry m⁻³. The highest and lowest specific growth rate values were 2.44±0.04 and 2.09±0.04 % observed in 1000 fry m⁻³ and 3000 fry m⁻³, respectively. The results revealed that stocking density showed inverse relationship with growth performance (length gain, weight gain, and specific growth rate) and survival. Therefore, on the basis of present work it is suggested that the stocking density of 1000 fry m⁻³ is suitable for better production of fry to fingerling of *Catla catla* in floating cages.

SPECIES COMPOSITION OF JUVENILES OF FRESHWATER PRAWNS OF RIVER AMBA FROM RAIGAD DISTRICT OF MAHARASHTRA

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Priyanka Chandrakant Bhoy	Registration No.: FRRTM0150304
Year of thesis submission: 2017	
Name of the research guide: Dr. A. S. Pawase	Designation: Professor

In Maharashtra, the river Amba of Nagothane is one of the established seed collection centres for wild collection of seed of the genus *Macrobrachium*. Present study was aimed at assessing the species composition of freshwater prawns from the River Amba. The seed of *Macrobrachium* was collected by local fishermen using traditional cylindrical bamboo traps and cylindro-conical traps made up of mid-rib of coconut leaflets traps placing in the river bed. Sampling was carried out every week according to the different phases of the lunar cycle during October 2016 to January 2017. The species identification revealed that composition consisted of seed of *Macrobrachium rosenbergii*, *Macrobrachium idella*, and *Macrobrachium scabriculum*. Month-wise species composition in number showed the maximum occurrence of *Macrobrachium rosenbergii* and *Macrobrachium idella* in October 2016 and the minimum in January 2017. *Macrobrachium scabriculum* had maximum occurrence in November 2016 and the minimum in January 2017. ANOVA showed significant difference (P<0.05) for the monthly occurrence. The monthly trends of occurrence for the species were strongly negative with a large size effect of r² = 0.80, r² = 0.60 and r² = 0.38 for *Macrobrachium rosenbergii*, *Macrobrachium idella*, and *Macrobrachium scabriculum*, respectively. Lunar cycle-wise data evinced the maximum occurrence in new moon and the minimum during full moon period for *Macrobrachium rosenbergii*. *Macrobrachium idella* had maximum occurrence in waning half-moon and the minimum occurrence in waxing half-moon days. *Macrobrachium scabriculum* showed the maximum occurrence in waxing half-moon and the minimum occurrence in full moon days. The statistical analysis showed that lunar cycle-wise trends for the species were strongly negative with a large size effects and ANOVA showed no significant difference (P>0.05) in the seed occurrence between the lunar cycles.

“Investigations on the prevalence of important viral pathogens in selected crustaceans of Ratnagiri coast”

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Shri. Vishal Mavalankar	Registration No.: FRRTM0150305
Year of thesis submission: 2017	
Name of the research guide: Dr. G.S. Ghode	Designation: Associate Professor (Aquaculture) (CAS)

A surveillance study was conducted on the Konkan coast covering three districts for the detection of white spot syndrome virus (WSSV) and infectious hypodermal and hematopoietic necrosis virus (IHHNV) in wild crustaceans. The samples of *Scylla serrata* and *Fenneropenaeus merguensis* were collected from seven locations. It included Shriwardhan from Raigad district, Harnai, Dabhol Jaigad and Ratnagiri from Ratnagiri district and Devgad and Malwan from Sindhudurg district. A total 350 samples collected in which 140 were of *S. serrata* and 210 were of *F. merguensis*. Two tissues were selected for analysis viz. gills and pleopods. The DNA was isolated by phenol chloroform method. Prevalence of WSSV and IHHNV from the wild stock of *S. serrata* and *F. merguensis* was determined by using first and nested polymerised chain reaction (PCR) method. WSSV was detected in both the specimens. WSSV was found to be more prevalent at Dabhol with 33% prevalence in *F. merguensis* pleopods and 100% prevalence in *S. serrata* pleopods. Similarly, *S. serrata* from Ratnagiri showed very prominent infection with 100% prevalence in pleopods and 50% in the gills. At the remaining five locations WSSV and IHHNV could not be detected in both *S. serrata* and *F. merguensis*. Thus, results of present investigation indicated presence of WSSV in wild stocks of *S. serrata* and *F. merguensis*.

Growth and immune gene expression by dietary supplementation of mannan oligosaccharide in fry of deccan mahseer, Tor khudree (Sykes, 1839)

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Ms. Aishwarya B.Ranadive	Registration No.: FRRTM0150306
Year of thesis submission: 2017	
Name of the research guide: Dr. S. J. Meshram	Designation: Associate Professor (CAS)

The experiment was carried out in five replicated groups for sixty days to know the effect of mannan oligosaccharide on growth and immune gene expression in fry of deccan mahseer, *Tor khudree*. In the experiment the fry (0.067 ± 0.02 g) were stocked at a rate of 30 fry/50 L in a plastic tub. The fry was fed with 38% protein diet incorporated with different levels of MOS (0.0 g/kg, 1.5 g/kg, 3.0 g/kg and 4.5 g/kg). The fry was fed for 60 days at a rate of 4% of body weight twice a day. Among the experimental diets, the diet containing 3.0 g/kg MOS showed significantly higher growth as weight gain (402.43 ± 15.17), length gain (70.023 ± 0.75), specific growth rate (2.62 ± 0.05), average daily growth rate (0.282 ± 0.80) and survival percentage (81.99 ± 1.3) were significantly different ($P < 0.05$) compared to other diets. Feed conversion ratio was better in diet containing 3.0 g/kg of MOS but there was no significant difference among the diets. In the immune gene expression study the primer were designed for the RT-PCR. Among which the housekeeping gene β -actin was amplified at 59°C.

The above results indicate that incorporation of MOS at a rate of 3.0 g/kg in diets of Deccan mahseer fry could enhance the growth performance.

Rearing of goldfish, *Carassius auratus* (Linnaeus, 1758) in biofloc system at different stocking densities

Degree: M.F.Sc.	Subject: Aquaculture
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Name of the Student: Shri. R. P. Waghmode **Registration No.:** FRRTM0150307

Year of thesis submission: 2017

Name of the research guide: Dr. R.M.
Tibile

Designation: Associate Professor
(CAS)

A study was undertaken to evaluate the growth and survival of goldfish reared in biofloc system at different stocking densities for a period of 12 weeks. The experiment was carried out in the wet laboratory of College of Fisheries, Shirgaon, Ratnagiri. The goldfish fry ($L = 22.29 \pm 0.60$ mm and $W = 0.15 \pm 0.005$ g) were stocked at densities of 30 fry 100 L^{-1} (T_1), 60 fry 100 L^{-1} (T_2), 90 fry 100 L^{-1} (T_3) and 120 fry 100 L^{-1} (T_4). The growth parameters (length gain, weight gain and specific growth rate), condition factor, survival and water quality parameters such as temperature, pH, dissolved oxygen, free carbon-dioxide, total alkalinity, total hardness, floc volume, total suspended solids, ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen were analyzed fortnightly.

The maximum growth i.e. average length, length gain, weight, weight gain and specific growth rate were observed in T_1 which were significantly higher ($P < 0.05$) than that of other stocking densities, whereas T_3 showed the minimum growth. The survival of 90 ± 1.1 , 78.3 ± 1.7 , 61.6 ± 3.0 and $31.8 \pm 0.8\%$ was observed in T_1 , T_2 , T_3 and T_4 , respectively. The survival in T_1 was significantly higher ($P < 0.05$) than other densities. The condition factor (K) did not vary significantly ($P > 0.05$) within the treatments. However, it increased significantly from the start to the end of experiment at all stocking densities. The higher ammonia-nitrogen levels were observed in T_4 till the end of culture period. The results indicated that stocking density had a negative effect on growth performance and survival of goldfish fry. The higher growth rate in T_4 was observed due to heavy mortality which reduced the number of fish less than T_2 . Thus, the effect of stocking density was not observed on growth of fry in that treatment. It can be concluded that, goldfish fry withstand, grow and survive in biofloc system with TSS level of 400-600 mg/L. Among the tested stocking densities, a density of 30 fry 100 L^{-1} was found to be suitable for obtaining better growth and survival of goldfish fry.

Effect of enriched Artemia on growth and survival of Carassius auratus (Linnaeus, 1758) larvae

Degree: M.F.Sc.

Subject: Fish Nutrition and Feed
Technology

Name of the Student: Miss. Jagruti Kashinath
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Registration No.: FRRTM0150308

Year of thesis submission: 2017

Name of the research guide: Dr. R.Pai

Designation: Associate Dean

The study was conducted to evaluate the effect of probiotic enriched artemia on growth and survival of the goldfish, *Carassius auratus* larvae. The larvae were divided in seven experimental groups with three replicates for each experiment. The feeding level was 30% of total biomass per day. Each experiment was carried out for fifteen days.

In experiment I, growth parameters, namely weight gain (750.82 ± 3.85 g), length gain (273.50 ± 1.67 cm), specific growth rate (14.27 ± 0.20), average daily growth (0.021 ± 0.00) were significantly higher ($P < 0.05$) in the artemia nauplii enriched with probiotic, *Bacillus* spp. at a concentration of 3.0×10^8 CFU.L⁻¹. In experiment II, the experimental design was similar to that of experiment I but for substituting the probiotic by *Lactobacillus* sp. The growth parameters, namely weight

gain (639.64 ± 3.70 g), length gain (145.29 ± 4.44 cm), specific growth rate (13.33 ± 0.22) and average daily growth (0.016 ± 0.00) were significantly higher ($P < 0.05$) in the artemia nauplii enriched with probiotic *Lactobacillus* sp. at a concentration of 1.5×10^8 CFU.L⁻¹. In experiment III, artemia nauplii enriched with n-3 HUFA rich emulsion individually, and in combination with the optimum concentration of probiotics as obtained in experiment I (*Bacillus* spp. 3.0×10^8 CFU.L⁻¹) and experiment II (*Lactobacillus sporogenes* 1.5×10^8 CFU.L⁻¹) executed separately. The growth parameters, viz. length gain (157.683 ± 1.3423), weight gain (658.849 ± 2.3460), average daily growth (43.92 ± 0.61), and specific growth rate (13.51 ± 0.08) showed significantly better performance in the latter experiment as compared to emulsion with *Bacillus* spp. concentration and only with emulsion.

USE OF DRY AND FERMENTED AZOLLA AS FISH MEAL SUBSTITUTE IN THE TILAPIA FRY DIET

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Sagar Kisan Hundare	Registration No.: FRRTM0150309
Year of thesis submission: 2017	
Name of the research guide: Dr. D. I. Pathan	Designation: Professor (CAS)

The present study was undertaken to evaluate the effect of dry and fermented azolla in the diet of fry of tilapia, *Oreochromis niloticus*. The experiments were conducted to assess the levels of azolla as fish meal substitute in the diet and its effect on growth and survival of fish.

The fry fish ranging between 2.160 ± 0.090 cm and 2.540 ± 0.060 cm and weight ranging between 0.190 ± 0.010 g and 0.210 ± 0.010 g were fed with practical basal diet (30% crude protein) in the form of pellets during the rearing period of 60 days. The dry azolla powder and fermented azolla were incorporated in the basal diet at various levels as T0 (control), T1 (10% dry azolla powder), T2 (20% dry azolla powder), T3 (30% dry azolla powder), T4 (10% fermented azolla), T5 (20% fermented azolla) and T6 (30% fermented azolla) to formulate six different test diets. The basal diet without incorporation of dry azolla powder and fermented azolla was used as control diet (T0). Among the experimental treatments, the treatment T5 showed significantly higher growth performance in terms of length gain ($178.586 \pm 11.313\%$), weight gain ($1346.770 \pm 70.251\%$), specific growth rate ($4.449 \pm 0.083\%$), average daily growth ($2.840 \pm 0.057\%$) and survival ($95.556 \pm 2.222\%$). The feed utilization in terms of feed conversion ratio (1.236 ± 0.030) was significantly lower in T5 than control group, whereas protein efficiency ratio (4.145 ± 0.169) in T5 showed significantly higher than that of other treatments.

Based on the results, it can be concluded that fry of Nile tilapia (*Oreochromis niloticus*) fed with diet containing 20% fermented azolla showed better growth, survival and feed utilization properties expressed in terms of feed conversion ratio (FCR) and protein efficiency ratio (PER) than other treatments while rearing for 60 days in laboratory condition.

COMPARATIVE STUDY ON GROWTH PERFORMANCE OF NILE TILAPIA FRY *Oreochromis niloticus* (Linnaeus, 1758) IN DIFFERENT LEVELS OF SALINITY

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Rameshwar Venkatrao Bhosale	Registration No.: FRRTM0150330

Year of thesis submission: 2018

Name of the research guide: Dr. B. R. Chavan **Designation:** Professor

The growth performance of GIFT Nile tilapia (*Oreochromis niloticus*) was studied in different levels of salinity, i.e. 0 PSU (T1), 5 PSU (T2), 10 PSU (T3), 15 PSU (T4), 20 PSU (T5), 25 PSU (T6) and 30 PSU (T7) in plastic tanks. The fry of GIFT Nile tilapia with an average initial length (3.06 ± 0.23 cm) and weight (0.51 ± 0.00 g) were stocked at a rate of 30 nos/per tank. Rearing experiment was conducted by using CRD design with seven treatments and three replicates for 60 days duration by feeding commercial floating tilapia feed (starter) having 32 % protein at a rate of 5 % of body weight.

The fry of Nile tilapia showed maximum average length gain of 230.47 ± 27.60 % in T1 and minimum in T5 (172.24 ± 11.48 %). The pattern was similar with regard to average weight gain and specific growth rate. The average weight gain (%) showed maximum in T1 (3719.81 ± 1.8739 % and minimum in T5 (2667.52 ± 1.640 %), while specific growth rate showed maximum in T1 (4.09 ± 0.0570 %) and minimum in T5 (3.74 ± 0.09 %). In all T1, T2 and T3 showed better growth response and survival rate as compared to higher levels of treatments (T4 and T5) with significant differences ($P < 0.05$). T6 and T7 showed total mortality in 60 days of experimental period.

The overall results of this study indicated that the salinity levels of 5 and 10 PSU showed significantly better growth performance as compared to higher levels of treatments. The values of other parameters such as pH and dissolved oxygen were within the acceptable range during the experimental period of 60 days.

Effect of different carbon sources on rearing of rohu, *Labeo rohita* (Hamilton, 1822) fry in biofloc system

Degree: M.F.Sc.

Subject: Aquaculture

Name of the Student: Miss. Anita Kute

Registration No.: FRRTM0160332

Year of thesis submission: 2018

Name of the research guide: Dr. R.M.

Designation: Associate Professor

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(CAS)

A study was undertaken to evaluate effect of different carbon sources on growth, survival and production of rohu (*Labeo rohita*) fry in biofloc system for a period of 90 days. The experiment was carried out using HDPE containers of 100 L capacity in the wet laboratory of College of Fisheries, Shirgaon, Ratnagiri. The fry (3.53 ± 0.46 cm) were stocked in 21 circular. A commercial floating feed having 32% dietary protein level was ground and soaked before adding to the experimental tanks. Different carbon sources used were wheat flour, wheat bran, rice bran, sugar, jaggery, barley and molasses. The growth parameters (length, length gain, weight, weight gain and specific growth rate), condition factor and survival were analysed monthly. The water quality parameters such as temperature, pH, dissolved oxygen, free carbon-dioxide, total alkalinity, total hardness, floc volume, total suspended solids, ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen were analysed at 15 days interval. The proximate composition was done for fishes and floc.

Growth and survival of fry was not affected by the kind of carbon source tested in the study ($p > 0.05$). However, the maximum average length of fishes was recorded in jaggery and wheat flour (7.22 ± 0.01 cm) incorporated treatment. The maximum values of average weight (4.09 ± 0.11 g), average length gain (108.02 ± 3.50 %), the average weight gain (739.00 ± 32.25 %) and specific growth rate (3.84 ± 0.09 %) and survival of (94.33%) were observed in wheat flour, jaggery, wheat bran,

molasses and rice bran groups respectively. The condition factor was statistically similar for all the treatments from day 60 till the end of experimental period ($P > 0.05$). The crude protein, crude lipid, ash content and nitrogen free extract (NFE) of fish at the start of experiment were 56.58%, 21.36%, 12.34% and 9.72%, respectively. At the end of experiment, average crude protein, ash content and nitrogen free extract were statistically similar among the treatment of different carbon groups ($p > 0.05$). In bioflocs, higher mean values of crude protein were found with sugar ($49.31 \pm 0.56\%$), crude lipid with ($19.65 \pm 0.35\%$), ash content and nitrogen free extract with rice bran groups ($17.64 \pm 0.56\%$ and 30.50 ± 1.34), respectively. It can be concluded that, different carbon sources showed similar growth and survival of rohu fry in biofloc system over a period of 90 days. Any of the carbon source tested in the study can be selected depending upon cost and availability for rohu fingerlings production in biofloc system.

**EVALUATION OF SELECTED DIETARY PROTEIN SOURCES
INCORPORATED IN PRACTICAL DIETS ON GROWTH PERFORMANCE
OF LABEO ROHITA
(Hamilton, 1822) FRY**

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Neeraj Ashok Chaskar	Registration No.: FRRTM0160333
Year of thesis submission: 2019	
Name of the research guide: Dr. D. I. Pathan	Designation: Professor (CAS)

The present study was undertaken to evaluate the effect of different dietary protein sources on growth, survival and body composition of fry during nursery rearing of *Labeo rohita*. Fry of *Labeo rohita* ranging from 3.37 ± 0.107 and 3.540 ± 0.031 (cm) in length and 0.450 ± 0.012 and 0.580 ± 0.005 (g) in weight were fed with seven isonitrogenous (30% CP) diets, viz, diet T1 (mustard oil cake + rice bran), diet T2 (soy bean oil cake + rice bran), diet T3 (sunflower oil cake + rice bran), diet T4 (fish meal + rice bran), diet T5 (sesame oil cake + rice bran) and diet T6 (copra + rice bran), respectively. Diet T0 (groundnut oil cake + rice bran) was the control diet, while in other diets, groundnut oil cake was substituted by other protein sources. The experiment was conducted for 60 days. Initially feed was distributed at 10% of body weight for 30 days duration and then reduced to 4% till the end of the experiment. Among the experimental treatments, the Diet T4 (FM+RB) showed the highest growth in terms of length gain (111.290 ± 3.562 %), weight gain (1017.711 ± 46.033 %), specific growth rate (2.945 ± 0.057 %), average daily growth (7.617 ± 0.176 %), but when compared among plant protein sources, Diet T2 (SOC + RB) showed highest growth rate in terms of length gain (95.609 ± 2.136 %), weight gain (841.646 ± 4.105 %), specific growth rate (2.723 ± 0.018 %), average daily growth (6.828 ± 0.223 %) followed by Diet T0 (GOC + RB). The feed utilization in terms of feed conversion ratio (1.306 ± 0.031) was significantly lower in Diet T2 (SOC + RB) than control group i.e Diet T0 (GOC + RB) (1.387 ± 0.094) and Diet T4 (FM+RB) (1.327 ± 0.032), whereas feed efficiency ratio (0.678 ± 0.020 ; 0.674 ± 0.018) and protein efficiency ratio (2.255 ± 0.065 ; 2.242 ± 0.059) was significantly higher and similar in Diet T4 (FM + RB) and Diet T2 (SOC + RB). After comparing the costs of the diets and

VII nutritional analysis, It is concluded that Diet T2 (SOC + RB) showed good growth and is cheaper, when compared with other selected protein sources, respectively.

EFFECT OF FEED SUPPLEMENTED *Lactobacillus sporogenes* ON GROWTH AND SURVIVAL OF *Pangasianodon hypophthalmus* (SAUVAGE, 1878) FINGERLINGS

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Priyanka Bharat Kuwar	Registration No.: FRRTM0160334
Year of thesis submission: 2018	
Name of the research guide: Dr. G. S. Ghode	Designation: Associate Professor (CAS)

The aim of this study was to assess the effect of feed supplemented *Lactobacillus sporogenes* on growth and survival of *Pangasianodon hypophthalmus* fingerlings for the duration of 60 days. The fingerlings of *Pangasianodon hypophthalmus* were reared at the stocking density 30 fish/100 L. A commercial probiotic containing *Lactobacillus sporogenes* at concentration 1.5×10^8 cfu/g was incorporated in feed at different levels i.e. 0% (T0), 0.1% (T1), 0.5% (T2), 1% (T3) and 1.5% (T4) of the diet. The fish were fed at 3% of body weight. The biological parameters i.e. growth (average length, length gain, average weight, weight gain, specific growth rate), survival, feed conversion ratio (FCR) were recorded at 30 and 60 days. After feeding trial the fish were challenged with pathogen *E. tarda* at 1×10^8 cfu/ml and observed for 15 days, growth (average weight, weight gain and specific growth rate) and survival were recorded at the end of 15 days. The haematological parameters (i.e. red blood cells (RBC), white blood cells (WBC), haematocrit (Hct), haemoglobin (Hb), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC)) and gut microflora were analyzed before and after exposure to *E. tarda*.

The biological parameters like average length, length gain, average weight, weight gain, specific growth rate, survival and feed conversion ratio (FCR) did not vary significantly ($P > 0.05$) at the end of 30 and 60 days. At the end of 60 days highest values for these parameters observed in treatment T1 (average length- 8.90 ± 0.26 cm, average weight- 4.80 ± 0.43 g, weight gain- $96.14 \pm 14.44\%$, specific growth rate- 1.11 ± 0.13 , survival- $99.17 \pm 0.83\%$, feed conversion ratio- 1.79 ± 0.42), however length gain was recorded to be the highest in treatment T2 ($31.95 \pm 3.85\%$). The average weight, weight gain, specific growth and survival rate of fishes in all

VIII treatments was found to be decreased after challenge with *E. tarda*. The haematological parameters of pangasius varied significantly ($P < 0.05$) among the treatments before and after challenge with *E. tarda*. However MCV and MCHC were similar in all treatments before and after challenge and WBC was similar after challenge. Before challenge the values of haematological parameters such as Hb (6.44 ± 0.08 g/dL), RBC ($3.14 \pm 0.07 \times 10^6/\mu\text{l}$), WBC ($54.84 \pm 0.96 \times 10^3/\mu\text{l}$), Hct ($24.83 \pm 0.58\%$) recorded to be significantly higher ($P < 0.05$) in treatment T2 than the control. However MCH (20.73 ± 0.56 pg) was statistically greater ($P < 0.05$) in treatment T1. There was slight decrease in hemoglobin, RBC, hematocrit, MCV, MCH and MCHC was found after challenge with *E. tarda*. However WBC was increased in all treatments. The highest gut microflora was found in treatment T4

(2.06×10^7 cfu/g) in unchallenged fish. After challenge it was higher in treatment T0 (1.48×10^8 cfu/g).

As per the objectives of study it can be concluded that inclusion of *Lactobacillus sporogenes* at different levels in the diet of *Pangasianodon hypophthalmus* improved the growth and survival in different treatments as compared to control, however, the improvement was not statistically significant. Further, after challenge with *E. tarda* growth and survival were decreased. However *Lactobacillus sporogenes* was found to be moderately effective immunostimulant against the pathogen *E. tarda* at the inclusion level 0.5% in diet as maximum haematological response was elicited at this inclusion level before and after challenge with *E. tarda*.

INTENSIVE REARING OF *LABEO ROHITA* (HAMILTON, 1822) FRY IN BIOFLOC SYSTEM USING VARIOUS DIETARY PROTEIN LEVELS

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Krupesh Sakharam Sawant	Registration No.: FRRTM0160335
Year of thesis submission: 2018	
Name of the research guide: Dr. S. J. Meshram	Designation: Associate Professor (CAS)

Experiment was conducted to evaluate the effect of varying dietary protein levels on growth and survival of *Labeo rohita* fry in biofloc system. Experiment was conducted in triplicate by following CRD for 80 days. Six experimental diets were prepared viz. D₁, D₂, D₃, D₄, D₅, D₆, with different dietary protein levels i.e 15%, 20%, 25%, 30%, 35%, 40% respectively for biofloc system and 30 % CP for clear water system as a control (D₀). Initial fry length (1.90 ± 0.17 cm) and weight (0.77 ± 0.01 g) was stocked in all treatments. After 80 days significant ($p < 0.05$) growth parameters were recorded in terms of average weight (4.34 ± 0.11 g), weight gain (5612.7 ± 215.09 %), length gain (289.43 ± 1.0 %), specific growth rate (1.95 ± 0.02 %) were observed in T₃ 25% CP as compared to other treatments in biofloc systems and clear water system. Higher survival (%) was observed in T₃ (25% CP).

Study concluded that, 25% CP feed can be used to rear *Labeo rohita* fry in biofloc system and crude protein (%) can be reduced up to 15% . Use of biofloc technology definitely assure growth and survival in rohu fry; also played role in water budgeting and eco-friendly aquaculture. Rohu fingerlings (55mm and 80mm) can be produced during 60 and 80 days of culture period respectively.

Survival and Growth of Rohu, *Labeo rohita* (Hamilton, 1822) Spawn at Different Stocking Densities and C/N ratios in Biofloc System

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Miss. Sushree Sangeeta	Registration No.: FRRTM0170364
Year of thesis submission: 2019	
Name of the research guide: Dr. R.M. Tibile	Designation: Associate Professor (CAS)

Biofloc technology-based culture system is a zero-water exchange system which is characterized by limited water exchange, improved water quality, continuous availability of adequate amount of live food and biosecurity, with a consequent intensified production. A study was carried out to investigate the

feasibility of biofloc technology for nursery rearing of rohu, *Labeo rohita* and to assess the effect of stocking density and C/N ratios on survival and growth of rohu spawn in biofloc system. In all, two experiments were conducted for spawn of size range 5 – 8 mm length and 1.50 – 1.57 mg weight in HDPE circular tanks of 120-L capacity for a period of 20 days each. The spawn were fed slurry of groundnut oilcake. In experiment I, the spawn were reared in biofloc system at five different stocking densities such as 1, 2, 3, 4 and 5 spawn L⁻¹, along with two control treatments of stocking densities 1 and 2 spawn L⁻¹ without biofloc system. The experiment was conducted with four replicates for each treatment following completely randomized design. The results showed that the fish reared at 1 and 2 spawn L⁻¹ density in the biofloc system achieved significantly ($p < 0.05$) highest survival percentage and showed good growth performance in terms of higher total length, length gain (%), weight, weight gain (%), daily weight gain, specific growth rate and lowest coefficient of variation in length and weight, and apparent feed conversion ratio compared to that of the other stocking densities in biofloc system and control groups. Consecutively, experiment II was conducted where the spawn were reared at a density of 2 spawn L⁻¹ on the basis of results obtained in experiment I. The experimental treatments included different C/N ratios, i.e., C/N 10, C/N 15, C/N 20, and a control treatment devoid of carbon source. The experiment was carried out with seven replicates for each treatments following completely randomized design for a period of 20 days. The results evinced that C/N 15 and C/N 20 experimental groups had significantly better ($p < 0.05$) survival percentage. A significantly better ($p < 0.05$) growth performance in terms of total length, length gain (%), weight, weight gain (%), daily weight gain, specific growth rate and lowest coefficient of variation in length and weight and apparent feed conversion ratio were achieved by fish reared at C/N 20 compared to other C/N ratios and control group.

The study revealed that the *Labeo rohita* spawn reared in biofloc-based system at stocking densities of 1 and 2 spawn L⁻¹ and C/N ratio of 20 exhibited better survival and growth than the controls for a period of 20 days.

**EFFECTS OF SUPPLEMENTATION OF DIETARY BAMBOOCHARCOAL
ON GROWTH PERFORMANCE AND SURVIVAL OF GRASS CARP,
(Valenciennes, 1884) FRY**

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Pawan Shivkumar Kale	Registration No.: FRRTM0170365
Year of thesis submission: 2019	
Name of the research guide: Dr. V. R. Vartak	Designation: Scientist (Fish)

Grass carp, *Ctenopharyngodon idella* is one of the most favored and cultured freshwater finfish in world as it has the highest reported production in aquaculture in the world with over five million tons per year (6,068,014 tons in 2016, FAO fish stat). Grass carp was introduced in water bodies of different countries as biological control of various aquatic weeds (Shetty & Nandeesh, 1989). It has become one of the main species of composite culture due to its fast growth and its feeding behavior. But its high growth is depend upon availability of aquatic vegetation as their acceptability to pelleted feed is comparatively low. Grass carp in some localities, however has low acceptance due to muddy smell. To overcome such problems it is important to use various feed additives to improve acceptability of feed by fish and to reduce the

unwanted smell from fish and culture water. Bamboo charcoal is known as universal absorbent due to its special structure containing number of tiny pores oriented in many directions for the better absorption of the toxic materials due to high surface area nearly about 385 m²/g (Fu et al, 2010, Shenxue, 2004). Bamboo charcoal (BC), which is obtained by pyrolysis process is mainly used for water treatment, removal of obnoxious gases and to remove toxins and impurities from water as well as digestive tract of terrestrial and aquatic animals. So it is considered as one of the important feed additive. In the experiment, grass carp fry having an average length (2.5 ± 0.01cm) and weight (0.27 ± 0.01 gm.) were fed with practical basal diet in the flake form having 30% crude protein for experimental duration of 60 days. Bamboo charcoal powder was incorporated in basal diet at different levels. @ 1%, 2% and 3% respectively. Experimental diet having no bamboo charcoal inclusion (0% BC) was considered as control treatment diet. Among all the experimental treatments, treatment T3 showed significantly better (P<0.05) and higher growth parameters. Treatment T3 showed significant higher length gain (74.27 ± 1.39%), weight gain (371.91 ± 9.27%) and specific growth rate (SGR) (2.58 ± 0.03%) values compared with other experimental treatments. Survival percentage of grass carp fry in different experimental treatments were not statistically significant. Feed utilization parameter such as feed conversion ratio (FCR) was significantly lower (P<0.05) and better in experimental treatment T3 (1.3 ± 0.03).

It is concluded that flake feed (30% crude protein) incorporated with 2% bamboo charcoal powder was optimum for better growth, survival and feed utilization of grass carp, *Ctenopharyngodon idella* fry.

GROWTH AND SURVIVAL OF ROHU, *LABEO ROHITA* (HAMILTON, 1822) SPAWN IN BIOFLOC SYSTEM BY USING DIFFERENT PPLEMENTARY FEEDS AND FEEDING RATES

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Harsha Vitthal Meshram	Registration No.: FRRTM0170366
Year of thesis submission: 2019	
Name of the research guide: Dr. S. J. Meshram	Designation: Associate Professor (CAS)

Experiment was conducted to evaluate the growth and survival of *Labeo rohita* spawn reared in biofloc system with different supplementary feeds and feeding rates for twenty days. First experiment was conducted with three treatments and seven replications of each treatment by employing CRD design. The average initial spawn length (0.5±0.01cm) and weight (1.51±0.01mg) were stocked at the rate 3 no. L-1 in each treatment. In this experiment three different supplementary feeds were used for spawn of rohu. The treatments were T1 groundnut oil cake (GOC), T2 rice bran (RB) and T3 the combination of both (1:1) respectively. Supplementary feed was given at the rate of 400% of total biomass for first five days and it was increased to 800% for next subsequent days. The growth parameters such as length, length gain percentage, weight, weight gain percentage, specific growth rate and survival were analyzed after experiment. The water quality parameters such as temperature, pH, dissolved oxygen, free carbon-dioxide, total alkalinity, total hardness, floc volume, total suspended solids, ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen were analyzed at 5 days interval. After 20 days no significant differences were observed between the treatments for growth parameters, whereas significant difference was observed in survival in treatment T2 which was 96.96%.

In the second experiment different feeding rates were tested viz. 100%, 200%, 300%, 400% and 500% of biomass for first five days then it was increased to 200 %, 400 %, 600 %, 800 % and 1000 % for next subsequent days. Significant differences were observed in length, length gain percentage, weight, weight gain percentage, specific growth rate and survival percentage in T4 (400 % feeding rate) as compared to other treatments.

Study concluded that, the use of rice bran is best supplementary feed in nursery rearing of rohu spawn reared in biofloc system and feeding rate of 400% for first five days followed by 800% of biomass showed better growth and survival in nursery rearing of spawn to fry in biofloc system. Use of biofloc technology definitely helps to reduce supplementary feed cost, increased survival percentage, intensive rearing and also played role in water budgeting and eco-friendly nursery rearing of rohu spawn.

“Effect of feed supplemented *Lactobacillus sporogens* on growth, survival and gut microflora of tinfoil barb, *Barbonymus schwanenfeldii* (Bleeker, 1854) juveniles”

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Manjusha Vutukuri	Registration No.: FRRTM0170367
Year of thesis submission: 2019	
Name of the research guide: Dr. G. S. Ghode	Designation: Associate Professor (CAS)

An experiment was conducted to analyze the effect of feed supplemented *Lactobacillus sporogens* on growth, survival and gut microflora of Tinfoil barb, *Barbonymus schwanenfeldii* fingerlings. The fingerlings of size 4.20 ± 0.06 g were stocked at 30 fish 100 L. A basal diet containing 40% crude protein was prepared using locally available ingredients which was used as control diet (T0). The commercial probiotic containing 1.5×10^8 cfu g⁻¹ of *Lactobacillus sporogens* was incorporated in the basal diet at different levels i.e. 0.5% (T1), 1% (T2), 1.5% (T3) and 2% (T4) was given to fishes at 3% body weight for 80 days. Thereafter, switched to basal diet for 20 days. The growth parameters (average length, length gain, average weight, weight gain, specific growth rate (SGR)), survival and feed conversion ratio (FCR) were recorded for every 15 days interval of experimental duration. The gut microbial count was analysed at 45th, 80th and 100th day and histological analysis was done at 45th and 80th days of the experimental duration. Water parameters such as temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity and hardness were analyzed weekly.

The growth parameters like average length, weight, length gain, weight gain, SGR were found to be significantly better ($p < 0.05$) in fishes fed with 1% (T2) of probiotic for longer duration and the effect was observed even after cessation of probiotic. Similarly, FCR was significantly better ($p < 0.05$) in T2 treatment compared to other experimental groups. However, survival was not affected by the probiotic up to 30 days but, thereafter slight mortality was observed in fishes fed with higher concentration 2% (T4). The gut microbial analysis revealed that at 45 days both the total plate counts of nutrient agar and actinomycetes isolation agar were

Ifound to be significantly higher ($p < 0.05$) in fishes fed with 1% probiotic. However, at the end of 80 days the aerobic TPC was highest ($p < 0.05$) in T4 and actinomycetes count was highest in T2. When switched to basal diet aerobes count was significantly higher ($p < 0.05$) in T2 and actinomycetes count was found to be in T3. Histological analysis revealed that the fishes in T2 treatment were found to have intact mucosal layer with increased absorptive enterocytes and absorptive area of intestinal villi, well organized lamina propria with different types of cells. In fishes fed with probiotic concentration more than 1% there was poor mucosal layer and enterocytes were reduced in size as well as number and the number of goblet cells was increased.

Thus it can be concluded that in tinfoil barb, *Barbonymus schwanenfeldii* inclusion of probiotic bacterium *Lactobacillus sporogenes* at 1% (1.5×10^8 cfu g⁻¹) level of inclusion was found to be effective for better growth, survival and gut flora as well as for better intestinal morphology.

**STUDY OF BACTERIAL POPULATION OF INDOOR BIOFLOC
SYSTEM FOR REARING OF GIFT TILAPIA, *Oreochromis niloticus*
(Linnaeus, 1758)**

Degree: M.F.Sc.	Subject: Aquaculture
Name of the Student: Ediga Arun Goud	Registration No.: FRRTM0180386
Year of thesis submission: 2020	
Name of the research guide: Dr. B. R. Chavan	Designation: Professor

A study was undertaken to evaluate the bacterial count, predominant bacteria of biofloc and also to assess the growth and survival of GIFT tilapia fry using different carbon sources in biofloc system for a period of 90 days. The experiment was carried out using HDPE tanks of 100 L capacity in the wet laboratory of College of Fisheries, Shirgaon, Ratnagiri. Fry (4.40 ± 0.03 cm) were stocked in 20 circular tanks following Completely Randomized Design. The fry were stocked at 250 nos. m³. A commercial floating feed having 35% dietary protein level was added to the experimental tanks. Different carbon sources used were molasses (T1), sugar (T2) and jaggery (T3) along with control (T0). The growth parameters (length, length gain, weight, weight gain and specific growth rate) and survival were analysed fortnightly. The water quality parameters such as temperature, pH, dissolved oxygen, free carbon-dioxide, total alkalinity, total hardness, floc volume, total suspended solids, ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen were analysed at 15 days interval. Bacterial count were also were analysed at 15 days interval.

Growth and survival of fry was not affected by the kind of carbon source tested in the study. All carbon sources showed better growth than the control. However, the maximum growth i.e. average length, length gain, weight, weight gain and specific growth rate were observed in T1 which were significantly higher ($P < 0.05$) than that of T2, T3 and T0. The survival of 91.20 ± 1.50 , 86.40 ± 0.98 , 89.60 ± 0.98 and 82.40 ± 0.98 % was observed in T1, T2, T3 and T0, respectively. The survival in T1 was significantly higher ($P < 0.05$) than the other treatments. The higher NH₃-N levels were observed in T0 on the 30 day of the experiment and then decreased till the end of the experiment. This indicates that biofloc helps to maintain the ammonia-nitrogen levels at optimum ranges. Results revealed that the water quality parameters were within suitable range for rearing of GIFT tilapia fry.

Assessment of egg hatchability and spawn survival of deccan mahseer, *Tor khudree* (sykes, 1839)

Degree: M.F.Sc.	Subject: Aquaculture
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Year of thesis submission: 2020	
Name of the research guide: Mrs. V. R. Bhatkar	Designation: Assistant Professor

The present study was undertaken to evaluate assessment of egg hatchability and spawn survival of Deccan mahseer, *Tor khudree* (Sykes, 1839). The fertilized eggs of *Tor khudree* with a size ranging from 2.5 mm to 2.7 mm were kept for incubation in 500 L FRP tank inside the rectangular floating plastic trays (31.5 x 23 x 10.5 cm). The eggs were kept to the different treatment at a rate of 100 (Exp.-I) and 120 (Exp.-I) no. tray⁻¹. Both the experiments were carried out for a period of 10 days each. Both the experiments were conducted as per the Completely Randomized Design with six treatments having four replications. Experiment I was carried out to determine the optimum water hardness level for incubation and egg hatching of Deccan mahseer, *Tor khudree*. The fertilized eggs were kept with six different water hardness treatments such as T₀ (25 mg L⁻¹), T₁ (75 mg L⁻¹), T₂ (125 mg L⁻¹), T₃ (175 mg L⁻¹), T₄ (225 mg L⁻¹) and T₅ (275 mg L⁻¹). Among the treatments, treatment T₁ (75 mg L⁻¹) showed significantly better growth performance of egg diameter (3.44 ± 0.07 mm), incubation period (49 ± 0.71 h), length of spawn (14.13 ± 0.24 mm) and fertilization rate (86.5 ± 4.44 %). Significant difference was observed in egg diameter, incubation period, length of spawn and post-hatch survival. The hatching rate was found to be similar between various treatments (98.57 ± 0.22 %) and (98.56 ± 0.69 %) and post-hatch survival rate (80.21 ± 1.42%) and (80.21 ± 3.22) observed in treatment T₁ (75 mg L⁻¹) and T₂ (125 mg L⁻¹). No significant difference was observed in fertilization rate and hatching rate.

Experiment II, was carried out to determine the optimum range of pH for egg incubation and hatching of Deccan mahseer, *Tor khudree*. The fertilized eggs were reared with six different water pH treatments such as T₀ (6-pH), T₁ (6.5-pH), T₂ (7-pH), T₃ (7.5-pH), T₄ (8- pH) and T₅ (8.5-pH). Higher egg diameter (3.2 ± 0.68 mm), incubation period (49 ± 0.41 h), length of spawn (12.15 ± 0.33 mm), fertilization rate (94.75 ± 0.85 %) and post-hatch survival rate (88.75 ± 2.02 %) were observed in treatment T₄ (8- pH). Significant difference was observed in egg diameter, incubation period, length of spawn, fertilization rate and post-hatch survival rate. Similar hatching rate (99.5 ± 0.29) was observed in treatment T₃ (7.5-pH), T₄ (8- pH) and T₅ (8.5-pH). The study indicated that the water hardness of 75 mg L⁻¹ was a suitable water hardness level for the egg diameter (after water absorption), incubation period, and spawn length gain and fertilization rate of *Tor khudree*. Similar, water pH level was found suitable for egg diameter (after water absorption), incubation period and fertilization rate, post-hatch survival rate and spawn length gain. The pH ranging from 7.5 to 8.5 was found more suitable for hatching of *Tor khudree* eggs.

Effect of water hardness on egg hatchability and larval viability of rohu, *Labeo rohita* (Hamilton, 1822)

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Year of thesis submission: 2020	
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The experiments were carried to assess the effect of water hardness and Ca:Mg ratio on egg hatchability and larval viability of *Labeo rohita*. In first

experiment, eggs and milt obtained through stripping were fertilised, hardened and incubated in different media with total hardness levels of 25, 75, 125, 175, 250 and 350 mg L⁻¹. In second experiment, the eggs were fertilised and incubated in media with different Ca:Mg ratios of 100:0, 75:25, 50:50, 25:75 and 0:100 at two hardness levels of 75 and 125 mg L⁻¹. The different levels of hardness and the selected Ca:Mg ratios at two levels were prepared by dissolving calcium chloride and magnesium chloride in distilled water. Distilled water and hatchery water served as controls. The experiments were set as per completely randomised design keeping three replicates for the first and four replicates for each treatment for second experiment. The eggs were incubated in inverted cylindro-conical plastic bottles of 2 L capacity at a density of 100 eggs L⁻¹. In the first experiment, the diameter of egg was higher in lowest water hardness treatments and reduced as the water hardness increased (p<0.05). Better egg fertilisation, hatching rate, post-hatch survival and spawn length were seen in treatments having water hardness of 75 and 125 mg L⁻¹ CaCO₃ in first experiment (p<0.05) whereas these parameters were found to be better in the medium with Ca:Mg ratio of 75:25 at hardness level of 75 mg L⁻¹ in second experiment (p<0.05).

The results suggested an optimal total hardness level of 75 mg L⁻¹ with Ca:Mg ratio of 75:25 for better egg fertilisation, hatching rate and spawn yield of *Labeo rohita*.

Assessment of supplementation of dietary black soldier larvae meal on growth and survival of arowana, *Osteoglossum bicirrhosum* (Cuvier, 1829)

Degree: M.F.Sc.

Subject: FNB

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Year of thesis submission: 2020

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Experiment was conducted to evaluate the effect of varying levels of dietary black soldier fly larvae meal on growth and survival of arowana, *Osteoglossum bicirrhosum* fingerlings. Four experimental diets were prepared i.e. T₀, T₁, T₂ and T₃ with different dietary black soldier fly larvae meal levels i.e. 0%, 10%, 20% and 30% respectively and T₄ (Commercial Hikari food for arowana) used as control diet. Experiment was conducted as per CRD in quadruplicate.

Fingerlings of initial average length (15.43 ± 0.83 cm) and weight (14.32 ± 2.82 g) were reared in glass aquarium tank (60cm×30cm×30cm) for 90 days. Everyday fingerlings were fed artificial pelleted diets at the rate 4 % of the body weight for first 60 days then feed rate was reduced to 3%. After 90 days significant (P < 0.05) difference in growth parameters were observed. Higher length gain was recorded in T₁ (56.85 ± 1.75%) followed by T₄ (54.34 ± 2.21%). The weight gain was observed higher in the T₁ (370.97 ± 40.63%) followed by the T₄ (337.78 ± 50.29%) and the T₀ (268.83 ± 29.23%). ADG, SGR, FER, PER were found to be higher in T₁ and better FCR was observed in T₁. No significant difference was observed in survival among the treated groups.

This study concluded that, 10% black soldier fly larvae meal incorporated feed can be used to fed arowana fingerlings without any adverse effect. Use of this feed for arowana assure growth, also economical compared to commercial diet tested in this study. Arowana of 15 cm length can be grown up to a length of 26 cm in a period of 90 days.

Effect of supplemental dry banana powder as prebiotic and *Bacillus* sp. as probiotic in practical diet of common carp, *Cyprinus carpio* (Linnaeus, 1758), fry

Degree: M.F.Sc. Subject: Fish Nutrition and Feed Technology
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Year of thesis submission: 2020
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An experimental study was conducted to assess the growth and survival of *Cyprinus carpio* fry using prebiotic (dry banana powder) and probiotic (*Bacillus* sp.) supplemental feed.

First experiment was conducted with supplementation of different levels of prebiotic 1% (T2), 2% (T3) and 3% (T4) along with probiotic (1 g.kg⁻¹) in basal diet and diet without any supplementation served as control (T1). Five replicates were provided for each dietary treatment. The fry of average initial length (2.63 ± 0.27 cm) and weight (0.26 ± 0.07 g) were stocked at the rate of 30 fry per 100 L. In this experiment, basal diet containing 30% crude protein was prepared using locally available ingredients and was used as control diet (T1). Fry were fed at 5% body weight per day for a period of 60 days. During experiment I, growth parameters (length gain, weight gain and specific growth rate) were found to be significantly better (P < 0.05) in fishes fed T3 (dry banana powder 2% along with *Bacillus* sp. 1 g.kg⁻¹). Similarly, feed conversion ratio was significantly better (P < 0.05) in T3 compared to control diet. The highest survival was observed in T3 which was not significantly different than other diets (P > 0.05).

In the second experiment, fry of average initial length (2.62 ± 0.22 cm) and weight (0.22 ± 0.06 g) were stocked at the rate of 30 nos. per 100 L for a period of 60 days. In this experiment, a basal diet without any supplementation served as control (T1), diet with only probiotic (*Bacillus* sp. 1 g.kg⁻¹) (T2), diet with only prebiotic (dry banana powder 2%) (T3) and diet with combination of prebiotic and probiotic (T4, best treatment from experiment I) served as experimental diets. During experiment II, growth parameters (length gain, weight gain and specific growth rate) and feed

VI conversion ratio were found significantly better (P < 0.05) in fishes fed T4 (dry banana powder 2% along with *Bacillus* sp. 1 g.kg⁻¹) and T2 (*Bacillus* sp. 1 g.kg⁻¹) diets compared to control diet. The survival in the control groups was significantly lower than other dietary treatments (P < 0.05).

The study concluded that, supplementation of dry banana powder (prebiotic) at the rate of 2% and *Bacillus* sp. (probiotic) at the rate of 1 g.kg⁻¹ improves growth performance, feed utilization and survival of *Cyprinus carpio* fry.

REARING OF GOLDFISH *Carassius auratus* (LINNAEUS, 1758) IN INDOOR BIOFLOC SYSTEM USING DIFFERENT CARBON SOURCES AND C/N RATIO

Degree: M. F. Sc. Subject: Aquaculture
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Effect of different carbon sources and C/N ratio on growth performance, survival, colouration and finnage of goldfish (*Carassius auratus*) indoor biofloc systems was assessed in the present study. Effect of three different carbon sources namely rice bran, molasses, wheat flour in combination with three C/N ratios of C/N 10, C/N 15 and C/N 20 was evaluated in the experiment. The experiment was carried out with nine treatments and three replicates following Completely Randomized Design (CRD) for a period of 90 days. A control group was provided without use of carbon source. Goldfish (*Carassius auratus*) fry were stocked at the rate of 30 fry per 100 L⁻¹ in circular HDPE containers. A commercial floating feed having 29% dietary protein level was given to the fishes. Growth performance of goldfish fry showed no significant difference (P>0.05) among different groups at the end of experimental period. The highest average total length (6.12 cm ± 0.20), length gain (139.90% ± 8.20), average weight (6.07 g ± 0.52), weight gain (1583.90% ± 136.03) were observed in biofloc group R-20 (carbon source: rice bran and C/N ratio: 20). Apparent feed conversion ratio (AFCR) was found to be better in the biofloc system but did not differ significantly (P>0.05) between various groups. The CV_{length} and CV_{weight} recorded at the end of the experiment showed no significant variation in size in different biofloc groups and control (P>0.05). The survival in all biofloc systems and control did not show any significant difference (P>0.05). The results showed that the lengths of the caudal fin, dorsal fin and fork length were not affected by the carbon sources and C/N ratios (P>0.05). The carotenoid content in the skin of goldfish was found to be higher in fish produced in the biofloc system (8.31 µg g⁻¹ ± 0.53) than the control (5.20 µg g⁻¹ ± 0.20). The biofloc system improved the carotenoid percentage of fish skin. The water required to produce one fish L⁻¹ was too low in the biofloc group (8.3 to 9.53 L per fish) in comparison with the control group (63.3 L per fish). The study indicated that any of the carbon sources tested in the present study keeping C/N ratio between 10-20 could be used for rearing goldfish fry for a period of 90 days in the biofloc system.

GROWTH AND PROXIMATE COMPOSITION OF ISOCHRYSIS GALBANA AND CHAETOCEROS CALCITRANS AT DIFFERENT SALINITIES

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Year of thesis submission: 2022	
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Effect of salinity on the growth and proximate composition of *Isochrysis galbana* and *Chaetoceros calcitrans* at different growth phases was analyzed in two different experiments. Both the experiments were carried out in 500 ml of Erlenmeyer flasks for subculture and 10L capacity plastic containers for mass culture. The experiments were subjected to four treatments T1 (10 psu), T2 (20 psu), T3 (30 psu) and T4 (40 psu) with five replicates using Completely Randomized Design (CRD). Each experiment was conducted for a period of 45 days. The f/2 medium and Conway nutrient media were used as a culture media for cultivation of microlagae. In experiment I, results showed that in sub culture of *I. galbana* reached the highest cell density (27.87 ± 0.56 ×10⁴ cells mL⁻¹) in an exponential phase at 30 psu salinity. In

mass culture, 40 psu was the best salinity in terms of the cell density ($29.37 \pm 0.77 \times 10^4$ cells mL⁻¹) and optical density (1.113 ± 0.039) observed in an exponential phase. The highest protein content was observed ($50.70 \pm 1.13\%$ dry weight) in stationary phase at 40 psu salinity. Lipid content was highest ($26.04 \pm 1.65\%$ dry weight) in exponential phase at 10 psu salinity while the highest carbohydrate content ($27.52 \pm 1.05\%$ of dry weight) was observed in stationary phase at 10 psu salinity. In experiment II, the optimum salinity level for *C. calcitrans* in sub culture was at 40 psu in exponential phase with the highest cell density ($38.27 \pm 0.84 \times 10^4$ cells mL⁻¹). In mass culture, the highest cell density ($32.44 \pm 0.87 \times 10^4$ cells mL⁻¹) and optical density were (1.534 ± 0.040) recorded at 30 psu mainly in exponential phase. Protein content was highest ($42.41 \pm 1.36\%$ dry weight) at 10 psu while lipid and carbohydrate content were highest at 40 psu with ($7.84 \pm 0.43\%$ dry weight) and ($43.06 \pm 1.99\%$ dry weight) in exponential phase. Therefore, this study indicates the importance of optimum salinity for the mass scale culture of *Isochrysis galbana* and *Chaetoceros calcitrans*. The range of salinity and growth phase of culture determines the nutrient profile of the essential biochemical compounds. The maximum cell density along with the suitable percentage of macronutrients is the required parameters in the finfish, crustacean and molluscan hatcheries

Growth and survival of pearlspot, *Etroplus suratensis* (Bloch, 1790) fry using practical diets incorporated with different levels of mosquito fern

Degree: M.F.Sc.	Subject: Fish Nutrition and Feed Technology
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Year of thesis submission: 2022	
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A study was carried out to investigate effect of azolla incorporated diets on growth and survival of *Etroplus suratensis* fry for 60 days. The fry with average length and weight of 25 ± 0.1 mm and 0.54 ± 0.03 g respectively were reared at stocking density 15 fry 100 L⁻¹ in brackishwater. Four iso-nitrogenous (30% crude protein) and iso-calorific diets were formulated with incorporation of 0, 10, 20 and 30% powdered fermented azolla. Fry were fed at the rate of 7 - 8% body weight per day. The highest growth parameters and survival were recorded for control diet. However, the fry fed 10% azolla incorporated diet showed similarities in weight gain %, specific growth rate and feed conversion ratio with control group ($p > 0.05$).

Effect of dietary supplementation of butyric acid on growth and survival of blue gourami, *Trichopodus trichopterus* (Pallas, 1770)

Degree: M.F.Sc.	Subject: FNB
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Year of thesis submission: 2022	
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An experiment was conducted to evaluate the effect of different dietary levels of butyric acid on the growth and survival of blue gourami (*Trichopodus trichopterus*) juveniles.

The present study was conducted in the year 2022 at wet laboratory of College of Fisheries, Shirgaon, Ratnagiri, Maharashtra, India to evaluate the effect of butyric acid on growth and survival in juveniles of blue gourami, *Trichopodus trichopterus* (Pallas, 1770). In the experiment the juveniles (2.33 ± 0.03 g) were stocked at a rate of 20 juveniles 54 L^{-1} in a glass tank. Five isonitrogenous and isocaloric experimental diet compounded by the supplementation in the basal diet with gradient sodium butyrate at SB (0 %, 1 %, 2 %, 3% and 4%) respectively. juveniles of blue gourami (with initial body weight of) were randomly allocated into five diet treatments has four replicates.

The juveniles were fed with 32% protein diet incorporated with different levels of SB (0 %, 1 %, 2 %, 3% and 4%). The juveniles were fed for 60 days at a rate of 4% of body weight twice a day. The water was exchanged once a day that is in morning session to remove the uneaten feed and faecal matter. Among the experimental diets, the diet containing 2% SB showed significantly higher growth as weight gain (188.56 ± 8.08 %), length gain (43.80 ± 3.81 %), specific growth rate (0.76 ± 0.01 % day^{-1}), protein efficiency ratio (0.14 ± 0.003) and survival percentage (100 ± 0.00 %) as compared to other diets. Feed conversion ratio was better in diet containing 2% of SB but there was no significant difference among the diets. The morphologic histology results showed the T₂ (2% SB incorporated diet) treatment had more goblet cells, microvilli length, and absorptive area than the T₁ (1%), T₃ (3%), T₄ (4%), and control. T₂ was found to have more dense microvilli than T₀, T₁, T₃, and T₄.

In conclusion our finding indicates that the increased growth performance and nutrient retention in fish fed the diets supplemented with SB 2% suggests that SB can be a desirable growth promoter as an antibiotic alternative in diets.

“Studies on the acute toxicity of Jatropha leaf extract on creeper shell and whiteleg shrimp *Litopenaeus vannamei* (Boone, 1931) post larvae”

Degree: M.F.Sc.	Subject: Aquaculture
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Year of thesis submission: 2022	
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The whiteleg shrimp (*Litopenaeus vannamei*) is a commercially important species cultured on a wide scale across the globe. Diseases and pests are major factors for economic losses. Infestations of other organisms, such as creeper shells (*Cerithidea cingulata*), in shrimp ponds are a significant issue in shrimp farming. Synthetic molluscicides are one of the conventional methods used in endemic areas to eradicate snail infestations. However, this is often discouraged because it has more disadvantages than benefits. As a result, the application of herbal molluscicides has been introduced in replacement of synthetic molluscicides. The broad-spectrum application of the jatropha plant is well documented. So, the present work was undertaken to study the acute toxicity of ethanolic extract of the leaves of *Jatropha curcas* against creeper shells and whiteleg shrimp post larvae in static bioassay test was assessed. Further, the safety period of jatropha leaf extract was also studied against whiteleg shrimp post larvae. Soxhlet apparatus was used for extract preparation.

Completely randomized design (CRD) with five treatments and three replications were used in this study for each pH level. The result showed that 96-hrs LC₅₀ values for the creeper shells were 1.62, 1.87, 2.16 and 2.32 mg mL⁻¹ at pH 7.0, 7.5, 8.0, and 8.5 respectively.

However, 48-hrs LC₅₀ values for the whiteleg shrimp post larvae were 0.30, 0.35, 0.57 and 0.94 mg mL⁻¹ for pH 7.0, 7.5, 8.0, and 8.5 respectively. For both exposed animals, the highest mortality was observed in the positive control (CuSO₄.5H₂O) while no mortality was recorded in the negative control (DMSO) within the same period. The residual effect of jatropa leaf extract was found to remain for six days. The coefficient of determination showed a strong positive relationship between the concentration and the mortality, suggesting that the extract has molluscicidal properties at higher concentrations. However, higher concentrations were found to be toxic to the whiteleg shrimp post larvae. Various factors could affect the toxicity of extracts such as the life stages of the exposed organisms, plant species and solvent used for extract preparation. Further detailed research is required to find out the suitability of jatropa leaf extract as a molluscicide for use in shrimp ponds.

Experimental studies on the embryonic hatching, post embryonic development and maturation of the fish, *Trichogaster trichopterus sumatranus* (Ladiges, 1933)

Degree: Ph.D.	Subject: Aquaculture
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Year of thesis submission: 2004	
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The fertilized eggs treated with 500 mgL⁻¹ sodium bicarbonate, the maximum hatching percentage (95%) was recorded, in the same dose lowest (22.64 hrs) total hatching period was observed and maximum (23.78 hrs) total hatching period was observed in the control. In the study of effect of various concentrations of sodium bicarbonate on the hatchling to free-swimming stage it was revealed that the maximum (87.5%) and minimum (72.5%) free-swimming percentage were recorded in 200 mgL⁻¹ and 600 mgL⁻¹ of sodium bicarbonate respectively.

Disodium hydrogen orthophosphate showed good impact on embryonic hatching, in 400 mgL⁻¹ of sodium hydrogen orthophosphate, the maximum hatching percentage (87.5%) was recorded while in just hatched larvae when treated with the same dose, the maximum free swimming percentage (91.25%) was recorded.

The lower dose of cobalt chloride was found to be effective in increasing hatching percentage as the maximum hatching percentage (83.75%) in 2 mgL⁻¹ of cobalt chloride while in the high dose of 8 mgL⁻¹, minimum hatching percentage (63.75%) was recorded. It was found that the highest free swimming percentage (87.5%) was recorded in 4 mgL⁻¹ of cobalt chloride.

When the fertilized eggs were immersed in the different concentrations of thyroxine, it showed high hatching percentage (93.75%) in 0.075 mgL⁻¹ of thyroxine while in the control less hatching percentage (73.75%) was recorded. The experiment revealed maximum free-swimming percentage (93.75%) in 0.05 mgL⁻¹ of thyroxine in hatchlings.

The different concentration of corticosteroid hormone was used for treating the fertilized eggs and maximum (85%) was recorded in 0.075 mgL⁻¹ of corticosteroid. this hormone have good impact on the post-embryonic development of the fish and the maximum free-swimming percentage (88.75%) was recorded in 0.05 mgL⁻¹ of corticosteroid.

The effects of 17 α -methyltestosterone on the maturation of the male and female fish were studied, maximum (0.43) and minimum (0.15) GSI in case of male

while in case of female, the maximum (3.7043) and minimum (1.97) GSI were recorded in 0.9 mgL⁻¹ diet of 17 α -methyltestosterone and control respectively.

In the maturation experiment of ethinylestradiol showed the maturation and growth of the male and female fish in 90 days experiment it was observed that in case of male, maximum GSI (0.34) was recorded in 4 mgkg⁻¹ diet of ethinylestradiol but higher doses showed reduction in GSI value.

**ECOLOGICAL STUDIES OF SOME BRACKISHWATER PONDS LOCATED
AT PANVEL-URAN AREA (DISTRICT:RAIGAD, MAHARASHTRA) IN
RELATION TO PRODUCTION OF TIGER SHRIMP, PENAEUS MONODON
(FABRICIUS)**

Degree: Ph.D.	Subject: Aquaculture
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Year of thesis submission: 2004	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

There are different agro-climatic zones along the east coast and west coast of India. Therefore, region specific ecological study is very essential to understand the complex interaction between stocked organisms and environmental factors for eco-friendly and sustainable shrimp farming. Due to rapid increase in shrimp farming activity in Raigad district of Maharashtra, which comes under north Konkan coastal zone, ecological study of shrimp ponds became essential. The present study was undertaken in the shrimp ponds located at Panvel-Uran area of Raigad district to investigate the ecological parameters such as water, sediment, plankton, productivity with growth, survival and production of *P. monodon*. In addition the impact of probiotic and stocking density on water, sediment, growth, survival and production of *P. monodon* was also attempted.

The literature pertaining to shrimp culture aspects including ecology, probiotic stocking density and economics has been reviewed. Standard methods were followed for analysis of physico-chemical and biological parameters of shrimp ponds.

1. During the present investigation, the temperature, salinity, ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, net primary productivity and total phytoplankton influenced the growth of *P. monodon* for the Crop I (December to April). During Crop II (May to September), the transparency, specific conductivity, total dissolved solids, salinity, free carbon dioxide, total hardness, calcium, magnesium, dissolved organic matter, ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, total phytoplankton, gross primary productivity and community respiration influenced the growth of *P. monodon* at both sites.
2. Sediment parameters such as temperature and available nitrogen for Crop I and pH, specific conductivity and available nitrogen for Crop II influenced the growth of *P. monodon* at both sites.
3. Crop II was found to be better in terms of production as compared to Crop I for the culture of *P. monodon* at both sites.
4. It is found that water probiotic has influenced the water parameters such as transparency, pH, alkalinity, dissolved organic matter, ammonia-nitrogen and nitrate-nitrogen and it increased about 34.16% of the total production of *P. monodon*, compared to control.
5. Stocking density of 6 shrimps m⁻² was found to be optimum for the improved

-
- extensive culture of *P. monodon* irrespective of the locality viz. Panvel and Uran.
6. The shrimp pond level economics showed that economic performance of Crop II was better than Crop I at both the sites.

Effect of diets on *Lamellidens corrianus* (Lea, 1834) and some aspects of pearl culture in captivity

Degree: Ph.D.	Subject: Aquaculture
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Year of thesis submission: 2005	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

Experiments were carried out to study effect of diets on *Lamellidens corrianus* and some aspects of pearl culture were undertaken in captivity. In Experiment I different methods for transportation of *L. corrianus* were evaluated. *L. corrianus* were transported by two different methods i.e. in air and in water to know the best method for transportation. Results of the study showed that air transportation was comparatively more stressful than water transportation.

In Experiment II, *L. corrianus* were stimulated by different methods for release of glochidia larvae and their infestation over the host fish. *L. corrianus* were stimulated by different methods such as physical (air exposure and mantle excision) and thermal stimulation, to release glochidia larvae under laboratory condition. Air exposure released average $1\ 42\ 667 \pm 5007$ number and mantle excision resulted in average $1\ 15\ 289 \pm 26\ 852$ number of active glochidia larvae. Due to thermal stimulation average number of active glochidia larvae released were $86\ 667 \pm 13\ 919$.

Experiment III was undertaken to assess the effect of different diets on condition index (CI) and proximate composition of *L. corrianus* released under captivity. The different diets viz. mixed algal culture, *Spirulina* powder suspension and groundnut oil cake suspension were fed to *L. corrianus* at concentration of 4×10^5 cells mL⁻¹, 40 mg L⁻¹ and 50 mgL⁻¹ respectively under laboratory conditions for the period of 12 months. It was concluded that the rate of decrease in protein, glycogen and lipid levels was lower in whole body tissue of *L. corrianus* fed mixed algal culture diets as compared to spirulina powder suspension and groundnut oil cake suspension diets.

Experiment IV was carried out to evaluate different diets for maturity in *L. corrianus* reared under captivity. *L. corrianus* were fed same as that of experiment III to remature the mussels under laboratory conditions and it was observed that highest number of oocytes were found in mussels fed mixed algal culture diet compared to mussels fed *Spirulina* suspension diet and groundnut oil cake suspension diet.

In Experiment V, evaluation of some relaxants for *L. corrianus* was carried out. Magnesium chloride, sodium bicarbonate, menthol crystals, clove oil and MS 222 were used at different doses to evaluate their effect on relaxation of *L. corrianus*. Clove oil (2 ml L⁻¹) was found to be efficient and cost effective chemical for relaxation.

Experiment VI was undertaken to study reuse of donor *L. corrianus* for pearl

culture. Mantle tissues from the relaxed *L. corrianus* were surgically removed by three different techniques viz. mantle excision from right valve, from left valve and from both the valves. Average survival was obtained in mussels excised on right valve, left valve and both valves was 98, 96 and 95%.

In Experiment VII, effect of different diets on nacre formation in *L. corrianus* was evaluated. Mixed algal culture diet was significantly better compared to *Spirulina* powder suspension and groundnut oil cake suspension diet for nacre formation and survival of *L. corrianus* after 180 days.

Experiment VIII was carried out to develop colour pearls using some chemicals. Pearls were treated with different concentrations of silver sulphate, silver nitrate, eosin, iodine, methyle orange, picric acid and giemsa's fluid to make colour pearls. Statistical analysis of score given by panelist revealed that silver nitrate pearls were the most significantly glossy and uniform coloured pearls and most accepted. Giemsa and silver nitrate treated pearls were most preferred for colour.

Studies on Biology, Ecology and culture of *Paphia malabarica* (Chemnitz) of Ratnagiri

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Mrs. S.A. Mohite	Registration No.: 2
Year of thesis submission: 2006	
Name of the research guide: Dr. S.G.Belsare	Designation: Senior Scientific Officer, M.B.R.S.

Several venerid clams species occur along the west coast of Maharashtra. *Paphia malabarica* is one of these important clams, which have formed vast beds in the Kalbadevi estuary (Shirgaon creek) and Kajali estuary (Bhatye creek), Ratnagiri. They are exploited on commercial basis throughout the year. From here, the clams are exploited for local as well as for external markets due to the heavy demand. The exploited live clams are kept in the sand along the Kalbadevi estuary, when there is no demand. As no work was done on the biology, ecology and culture aspects of this clam,

The present study was undertaken. Attempts have been made to study the resource potential and the abundance of *P. malabarica* in the Kalbadevi and Kajali estuaries. Growth of this clam was studied using length frequency method, from the data collected from February 2004 to January 2006. Reproductive biology was studied by assessing the maturity stages, sex ratio and condition index of the clams collected from Shirgaon (Kalbadevi estuary) and Bhatye (Kajali estuary). Seasonal variations in the proximate composition of the clams were also studied to understand the correlation of these factors with the gonadal conditions. Edibility and calorific values of the clams were calculated on the basis of the proximate analysis.

Economic and marketing analysis of shrimp farming in some districts of Konkan coast, Maharashtra

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Shri. K.J. Chaudhari	Registration No.: 6
Year of thesis submission: 2007	
Name of the research guide: Dr. H.T. Dhaker	Designation: Prof. and Head

In all 108 shrimp farmers, 15 shrimp processors and 10 market

intermediaries were considered for collecting data for analysis of production economics and marketing of cultured shrimps from three districts viz. Thane, Raigad and Sindhudurg. as such, all the operational shrimp farms in selected districts were considered for census sampling. However, final data were collected from farmers those who have taken two successful crops during 2004-05.

Along the Maharashtra coast, *P. monodon* shrimp farming was found to be profitable and economically viable enterprise. most profitable shrimp farming operations were in Raigad district. Similarly, most economic shrimp farm size was 2 to 4 ha water spread area. Seed and feed were most important inputs responsible for shrimp production. Risk analysis indicated that marginal farmers do not have capacity to bear the risk and small farmers have moderate capacity to bear the risk. Medium and large farmers have more capacity to bear the risk. For minimizing the risk, added cost of insurance premium was profitable for small, medium and large farmers however, it was not profitable for marginal farmers. Marketing analysis revealed that cultured *P. monodon* shrimp has most efficient market performance along Kokan coast as shrimp farmers enjoyed more than 95 per cent share in consumer's price.

Dietary lipid requirements of fry of Goldspot mullet, *Liza parsia* (Hamilton-Buchanan, 1822)

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Miss. G.P. Sawant	Registration No.: 9
Year of thesis submission: 2008	
Name of the research guide: Dr. H.T. Singh	Designation: Head and Professor

Lipid is the dietary component for energy and essential fatty acid source. Three experiments were conducted to study the effect of lipid level, fatty acid and oil sources on rearing of fry of *L. parsia*. In the first experiment, *L. parsia* (1.5 ± 0.5 cm, 0.038 ± 0.005 g) was fed with isonitrogenous purified diets containing different lipid levels viz. 0 (T₀), 2.5 (T₁), 5 (T₂), 7.5 (T₃), 10 (T₄), 12.5 (T₅) and 15% (T₆) containing sunflower oil: cod liver oil: lecithin (1:2:1) as the lipid sources. Experiment was conducted in aquarium tank for 90 days and having three replicates of each diet. Weight gain, specific growth rate and feed performance (FCR, FCE, PER and ANPU) were better in fish fed with the 5% (T₂) lipid diet. Body lipid content increased with lipid level but fatty acid was not influenced with dietary lipid level.

In second experiment *L. parsia* (1.4 ± 0.026 cm, 0.053 ± 0.002 g) fed with diet containing 5% Palmitic acid (T₁); 4.5% Palmitic and 0.5% 18:3n-3 (T₂); 4% Palmitic and 1% 18:3n-3 (T₃); 3% Palmitic and 2% 18:n-3 (T₄); 5% 18:3n-3 (T₅); 4.5% Palmitic and 0.5% 18:2n-6 (T₆); 4% Palmitic and 1% 18:2n-6 (T₇); 3% Palmitic and 2% 18:2n-6 (T₈); 5% 18:2n-6 (T₉); 4% Palmitic, 0.5% 18:3n-3 and 0.5% 18:2n-6 (T₁₀); 3% Palmitic, 1% 18:3n-3 and 1% 18:2n-6 (T₁₁); 2% Palmitic, 2% 18:3n-3 and 1% 18:2n-6 (T₁₂); 2% Palmitic, 1% 18:3n-3 and 2% 18:3n-6 (T₁₃) and 2.5% 18:3n-3 and 2.5% 18:2n-6 (T₁₄). Experiment was conducted with two replicates for each diet for 90 days. The results showed that better growth, feed performance (FCR, FCE, PER, LER, ANPU and ANLU) were found in T₆ diet containing 0.5% linolenic (18:3n-3) and 4.5% palmitic fatty acids. There was no influence on proximate composition by inclusion of fatty acids in the diets of *L. parsia*. Fatty acids in muscle tissue were influenced when they were incorporated in the diet. Desaturation of dietary palmitic acid while elongation of linolenic fatty acid was observed as EPA and DHA fatty acids were increased in the fish body muscles of *L. parsia*.

In experiment three, the fry of *L. parsia* fry (1.57 ± 0.04 cm, 0.039 ± 0.004 g)

was fed with twelve diets supplemented with cod liver oil + sunflower oil (T₁); cod liver oil + soyabean oil (T₂); cod liver oil + ground nut oil (T₃); cod liver oil + mustard oil (T₄); cod liver oil + linseed oil (T₅); cod liver oil + corn oil (T₆); sardine oil + sunflower oil (T₇); sardine oil + soyabean oil (T₈); sardine oil + ground nut oil (T₉); sardine oil + mustard oil (T₁₀); sardine oil + linseed oil (T₁₁) and sardine oil + corn oil (T₁₂). The experiment was conducted for 90 days with replication of each diet. The highest growth rate and feed performance was observed in sardine oil + linseed oil (T₁₁) incorporated diet. Proximate composition of body muscle of *L. parsia* was also not affected by the type of lipid sources. The feeding with soyabean oil and linseed oil containing diets increased the level of EPA and DHA in *L. parsia* muscle tissue.

In fourth experiment, the rearing of *L. parsia* fry in cages was carried out by using diet developed during the present study and compared with practical diet. Significant difference was found in weight gain, specific growth rate, survival and FCR in experimental diet compared to control diet.

The present investigation showed that 5% dietary lipid level, linolenic fatty acid and palmitic fatty acid at 0.5% and 4.5% incorporation and sardine and linseed oil as lipid sources are better for the growth performance and quality of flesh of the fry *L. parsia*.

**Phenotypic and heamatological studies of *Bangana diplostoma* (Heckel, 1838)
from different freshwater environments of Shrinagar**

Degree: Ph.D.

Subject: Aquaculture

Name of the Student: Romisa Gull

Registration No.: 4

Year of thesis submission: 2009

Name of the research guide: Dr. H.T.
Singh

Designation: Head and Professor

The fish, *Bangana diplostoma* (Ropput) inhabits both lentic and lotic fresh waters of Kashmir Valley. In the present study, the morphometric, haematological and reproductive biology of *B. diplostoma* from Dal Lake and River Jhelum were studied. The linear relationship was established between various lengths measurements while total weight on total length showed allometric growth. The study revealed the significant difference in morphometric parameters of *B. diplostoma* from Dal Lake and River Jhelum while meristic characters were not found to be significantly different in the two water bodies. The maximum growth of fork length in relation to total length was found in fishes of Dal Lake, while the standard length in relation to total length was more in fishes of River Jhelum.

The haematological parameters such as haemoglobin, erythrocytes, glucose, protein, haematocrit were found directly related with total length and total weight, while, leucocyte, MCH and MCHC showed inverse relationship with total length and total weight of *B. diplostoma* in both the water bodies.. It was also observed that haematological parameters of *B. diplostoma* were influenced due to sex and season in both the water bodies.

The present study revealed the five distinct maturity stages in both male and female *B. diplostoma*. The G.S.I and fecundity were observed more in River Jhelum as compared to Dal Lake. The fecundity was influenced by total length and total weight of the fish in both the water bodies.

Effect of different diets on the growth and reproductive performance of Neon tetra, *Paracheirodon innesi* (Myers, 1936)

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Miss. S.I. Darve	Registration No.: 13
Year of thesis submission: 2009	
Name of the research guide: Dr. H.T. Dhaker	Designation: Head and Professor

Eight experiments were conducted to evaluate the protein level, essential amino acid requirement, lipid sources and lipid level for the growth, survival, feed performance and reproductive performance (number of spawn, gonadosomatic index and matured oocytes) of *Paracheirodon innesi*, while live food (*Artemia nauplii*) was used as sGnRH hormone delivery system for inducing spawning.

The experiments I, III and IV were conducted to study the growth using semipurified diets containing different protein levels, lipid sources and lipid levels, while purified diet containing crystalline amino acids were used in experiment II. Experiments were conducted in aquarium tanks for the period of 90 days. Weight gain, specific growth rate and feed performance (FCE and PER) were better in fish fed with the 55% protein diet in the experiment I. The diets deficient in arginine, lysine, leucine, valine, and threonine resulted in lower growth and feed performance in the experiment II. Diet containing cod liver and corn oil (1:1) and 12% lipid level showed better growth and feed performance in experiment III and IV respectively.

The maximum number of spawn, gonadosomatic index and matured oocytes were recorded in 50% protein diet in experiment V. The diet containing cod liver oil and soya lecithin (1:1) as lipid sources in experiment VI and 10% lipid level diet in experiment VII resulted in better reproductive performance.

In the experiment VIII it was found that the *Artemia nauplii* enriched for 30 minutes in water containing 100 µg sGnRH hormone showed highest spawning response.

STUDIES ON MATURATION, EXTRAPALLIAL FLUID AND NACRE SECRETION OF *Lamellidens marginalis* (Lamarck, 1819) IN CAPTIVITY

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Dabir I. Pathan	Registration No.: 12
Year of thesis submission: 2011	
Name of the research guide: Dr. H. T. Dhaker	Designation: Professor and Head

1.0 Morphological, morphometric and DNA sequencing of *L. marginalis*

Freshwater Mussels, *Lamellidens marginalis* were collected from Adre dam, Chiplun, Dist : Ratnagiri, Pawashi dam, Mulde, Dist Sindhudurga, Fish Seed production Centres at Khopoli, Dist. Raigad and Kolhapur. The identity of the species was established based on morphometric characters such as length to middle height : 1.98 ± 0.018 , length to middle width : 2.95 ± 0.046 , anterior length to anterior height : 0.66 ± 0.021 , anterior length to anterior width : 1.70 ± 0.029 , posterior height to posterior width : 1.73 ± 0.031 , ligament to total length : 0.51 ± 0.007 , middle height to middle width : 1.49 ± 0.023 , umbo length to posterior height : 2.20 ± 0.029 , area of anterior adductor mussel to length : 1.10 ± 0.021 and area of posterior adductor mussel to

length : 0.98 ± 0.021 . illustrated by earlier workers and a re-description of the species was described based on morphological, morphometrical characters. mtDNA - Cytochrome oxidase subunit I (COI) sequence of the confirmed specimens was carried out and were of 609 bp, 604 bp, 599 bp and 602 bp to support the systematic details along with molecular tool.

2.0 Study of the proteins and inorganic composition of Extrapallial fluid of *L. marginalis*

The analysis of the extrapallial fluid of *L. marginalis* was carried out to study its composition. The average protein concentration value was $460.8 \pm 0.018 \mu\text{g mL}^{-1}$ in the fluid. Amino acid profile showed presence of amino acids such as eight essential viz. Arginine, Histadine, Theronine, Valine, Isoleucine, Lysine, Phenylalanine, Leucine and eight non essential amino acids viz. Alanine, Asparagine, Glutamine, Glycine, Proline, Serine, Tyrosine, Ornothine along with inorganic ions viz., Ca, Mg, Na and K.

3.0 Study of different techniques of implantation and comparative performance of different shapes of implanted material :

The comparative study between two methods i.e. mantle cavity insertion and drilling method revealed no significant difference between the implantation techniques. Average increase in nuclei diameter obtained was 0.11 ± 0.01 mm and 0.11 ± 0.03 mm in mantle cavity insertion and drilling method respectively. Nucleus were implanted in

mussels at three different locations i.e. anterior, middle and posterior of right and left valve of mussels to evaluate the suitable location for implantation. The anterior position of right and left valve was significantly different from middle and posterior position of both valves. Average increase in nuclei diameter in mussels implanted at right anterior, right middle, right posterior, left anterior, left middle and left posterior locations were 0.11 ± 0.01 , 0.11 ± 0.03 , 0.10 ± 0.01 , 0.11 ± 0.01 , 0.10 ± 0.03 and 0.09 ± 0.01 .

Mabe and nucleus were used as a implantation material to study the comparative performance of different materials. Higher coating percentage was observed in mabe as compared to nucleus. Average increase in nucleus and mabe weight over 180 days period was 9.91 ± 0.35 mg and 0.14 ± 0.26 g. The study was carried out for the duration of 180 days.

4.0 Effect of different diets on condition index, proximate composition and survival of *L. marginalis*:

Seven diets were used along with mixed algal culture as a control for the holding the *L. marginalis* in captivity and its effect on condition index, proximate composition and survival was studied. The condition index was not significantly different ($P < 0.05$) among the diets. The monthly variations in moisture, protein, lipid, nitrogen free extract and ash content were observed for a period of twelve months. The moisture content (%) in all experimental diets i.e. T₀, T₁, T₂, T₃, T₄, T₅ and T₆ ranged between 76 to 81 % and increased moisture content was observed in T₄, T₅ and T₆ diets. Two-way analysis of variance (ANOVA) showed significant difference ($P > 0.05$) in moisture (%) due to the diets as well as holding period. The annual pattern of these specimens reared on different diets showed increasing trend in protein content during pre spawning months with a peak in November and June while during the post spawning months, a lower value was observed. The monthly variations in protein content showed the suitability of different diets for captive rearing as the specimens exhibited normal maturation cycle. The variations in nitrogen free extract (%) observed in specimens reared on seven experimental diets viz., T₀, T₁, T₂, T₃, T₄, T₅ and

T₆ showed a similar trend. All the specimens reared on different diets recorded a peak value during March and July while lower values were observed in November and June. Two-way analysis of variance (ANOVA) showed no significant difference (P>0.05) in nitrogen free extract (%) due to the diets as well as holding period. Annual trend of fluctuations in lipid content of specimens were observed and were directly correlated with the maturation of mussels showing the suitability and acceptance of diets. During pre-spawning period, an increasing trend was observed till spawning season while decrease in values were recorded during post-spawning months. Two-way analysis of variance revealed no significant difference (P > 0.05) in lipid (%) due to the diets and holding period. In the entire captive rearing of mussels, the average ash percentage ranged between 25 to 29 percent in all treatments. Treatment diets as well as holding period caused significant difference (P<0.05) in the ash (%) of mussels. The diet T₆ was significantly different from all remaining diets except T₅ while T₅ was significantly different from T₀, T₁, T₂, T₃ and T₄. The average mussel survival (%) in the diet treatments, T₀, T₁, T₂, T₃, T₄, T₅ and T₆ was 95, 91.67, 88.33, 86.67, 88.33, 83.33 and 80 respectively during the captive rearing for 12 months.

5.0 Effect of different diets on nacre coating and survival in *Lamellidens marginalis* during captive holding

Seven diets were used along with mixed algal culture as a control for the captive rearing of *L. marginalis* and its effect on coating percentage and survival was studied. Mabe implanted mussels were reared for a period of 12 months. The average coating percentages in the diet treatments T₀, T₁, T₂, T₃, T₄, T₅ and T₆ were 30.80 ± 0.39, 28.39 ± 0.34, 24.79 ± 0.43, 21.24 ± 0.40, 26.25 ± 0.35, 20.60 ± 0.58 and 14.27 ± 0.45 respectively. One-way analysis of variance (ANOVA) showed significant difference (P<0.05) between the nacre coating and diets. Based on the results, T₀, T₁, T₂, and T₄ showed better results than T₃ and T₅. Among all the diets, lower values were obtained in T₆ diet.

6.0 Effect of different environment on condition index and oocyte development in *L. marginalis*

Comparing the effect of environment on condition index (%) of mussels was recorded during the study period of twelve months. The condition index in natural environment was from 62.63 to 77.36 while in captive environment, the values ranged between 64.57 to 73.61. No significant difference (P>0.05) was found in the condition index of *L. marginalis* due to environment. Histological analysis, oocyte diameter was observed and the four stages of oocyte development were classified. No significant difference (P < 0.05) in oocyte diameter was observed during oocyte development of the mussels from natural and captive environment.

INFLUENCE OF DIETS ON GROWTH AND REPRODUCTIVE PERFORMANCE OF ANGEL FISH, *Pterophyllum scalare* (Schultze, 1823)

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Gauri Shelar	Registration No.: 14
Year of thesis submission: 2011	
Name of the research guide: Dr. H. T. Dhaker	Designation: Professor and Head

Five experiments were conducted to evaluate the effect of protein and lipid level, lipid sources, ration, frequency and replacement of live food by formulated feed for the growth and reproductive performance (relative fecundity, spawning interval, egg diameter, oil globule diameter, fertilization rate, hatching rate, relative hatchling

number, hatchling length, hatchling weight and egg and body composition) of *Pterophyllum scalare*.

In the experiment I, the effect of different protein and lipid level was evaluated and it is concluded that 400 g protein kg⁻¹ diet with 40 g lipid kg⁻¹ diet found better for growth while 450-500 g kg⁻¹ protein with 80 g kg⁻¹ lipid showed earlier maturation in *P. scalare*.

In the experiment II, the effect of different levels of dietary protein and lipid on reproductive performance of *P. scalare* was studied. At the end of the experiment it is found that *P. scalare* broodstock fed with 500-520 g kg⁻¹ protein and 120 g kg⁻¹ lipid showed better egg and larval quality.

Experiment III showed that *P. scalare* broodstock fed with either corn oil or soybean oil with cod liver oil diet showed better reproductive performance.

In the experiment IV, relative fecundity, fertilization rate, hatching rate, egg size and relative hatchling number, were significantly high in group fed with 6 and 8% body weight twice a day.

In the experiment V, it is concluded that live food can be replaced up to 50% by developed formulated feed for better reproductive performance of *P. scalare*.

STUDIES ON INTERACTION OF DIETARY PROTEIN AND ENERGY IN GOLDFISH, *Carassius auratus*

Degree: Ph.D.

Subject: Aquaculture

Name of the Student: Satyajit Sharad

Registration No.: 11

Belsare

Year of thesis submission: 2016

Name of the research guide: Dr. H. T.

Designation: Senior Scientific

Dhaker

Officer

The present study was conducted to evaluate the effect of dietary protein and lipid levels, dietary carbohydrate to lipid ratios (CHO : L), feeding ration and frequency on the growth and feed utilization parameters, body indices, proximate body composition, digestive enzymes and blood plasma components of young ones of *Carassius auratus*.

In the experiment I, six diets containing two protein levels (300 and 400 g kg⁻¹) and three lipid levels (40, 80 and 120 g kg⁻¹) were formulated and fed to *C. auratus* (1.66 ± 0.02 g) for 8-weeks. The results showed that weight gain and SGR increased in response to higher dietary proteins with the highest weight gain and SGR recorded in diet containing 400 g kg⁻¹ protein with 80 g kg⁻¹ lipid. Both feed intake and PER were dependent on dietary protein and lipid level (P < 0.05). Lipid retention was negatively correlated, while HSI and VSI was positively correlated with dietary lipid levels. Whole body protein content decreased (P < 0.05), while lipid content increased with increasing dietary lipid at each protein level. Second-order polynomial regression revealed that diet containing 400 g kg⁻¹ protein level and 80 g kg⁻¹ lipid level was optimal for the better growth and feed utilization of *C. auratus*.

In the experiment II, five isonitrogenous (400 g kg⁻¹ crude protein) and isoenergetic (18.52 MJ gl) diets with varying CHO : L ratios (1.04 to 38.42) were fed to *C. auratus* (1.69 ± 0.01 g) for 8-weeks. Weight gain, SGR, FCR and PER improved significantly (P < 0.05) as dietary CHO : L ratio increased however, this trend was not observed above CHO : L ratio of 4.33. HSI increased significantly (P < 0.05) as dietary CHO : L ratio increased, whereas, VSI followed an oppositetrend (P < 0.05). Opposite to moisture content, whole body lipid content increased significantly (P < 0.05) as dietary CHO : L ratios decreased, while whole body protein showed

significant difference ($P < 0.05$) among all the treatments. Based on second-order polynomial regression analysis of SGR, the dietary CHO : L ratio of 3.86 was optimum for growth and feed utilization of *C. auratus*.

Effect of different feeding ration and feeding frequency on growth and survival of *C. auratus* were evaluated in experiment III. Feeding ration, feeding frequency as well interaction of both the factors significantly influenced ($P < 0.05$) the growth as well as feed utilization parameters of *C. auratus*. The weight gain SGR, FCR and PER were significantly better ($P < 0.05$) at feeding ration of 3% BW day⁻¹ and improved with increase in number of meals per day upto 4 meals. Weight gain, SGR, FCR and PER was reduced when feeding ration was increased beyond 3% BW day⁻¹. Whole body crude lipid content of fishes increased, while ash content decreased with the increase in feeding ration at all the feeding frequencies. Improvement in crude lipid content was observed with the increased feeding frequency at all feeding rations, while moisture content of fishes showed an opposite trend to crude lipid content and decreased with increase in feeding frequency. Thus, the feeding ration of 3% BW day⁻¹ and feeding frequency of 4 meals day⁻¹ was found to be better for maximal growth and feed utilization of *C. auratus*.

Effect of immunostimulants on health status of striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878)

Degree: Ph.D.	Subject: Fish Nutrition and Feed Technology
Name of the Student: Sagarika Swain	Registration No.: FRRTD0150027
Year of thesis submission: 2018	
Name of the research guide: Dr. A. S. Pawase	Designation: Professor
<p>Effect of immunostimulants on health status of juvenile striped catfish, <i>Pangasianodon hypophthalmus</i> was analysed in two separate experiments followed by challenging the fishes to bacterial pathogen, <i>Aeromonas hydrophila</i>. Both the experiments were conducted in 20 fiberglass tanks each of 400 l capacity with 50 fishes per tank. The experiments were subjected to five treatments and four replicates using completely randomised design (CRD). Experimental duration was 90 days in both the experiments. In Experiment 1. effect of four different immunostimulants such as brewer's yeast, vitamin C, vitamin E and ginger powder was compared with commercial diet as control. Results showed that of the five tested diets, ginger incorporated diet showed significantly better percentage weight gain and feed conversion ratio ($P < 0.05$) as compared to other tested diets. However, the survival percentage was higher in all the tested diets. Dietary ginger significantly increased Hb, RBC, WBC, Hct, serum protein, albumin, globulin, phagocytic, lysozyme activity and NBT assay in the pre- as well as post-challenge study ($P < 0.05$). In Experiment 2, a ginger incorporated diet that resulted in better response in experiment 1 was tested in various levels of incorporation such as 5, 10, 15 and 20 g kg⁻¹ in the experimental diets. Control diet was kept without any immunostimulant added in the basal diet. The percentage weight gain and specific growth rate were observed higher in ginger diet with incorporation level of 10 g kg⁻¹ diet, while the percentage survival was higher in all levels, of incorporation of ginger. Similarly, the diet also showed significant increase ($P < 0.05$) feed conversion ratio in the fishes as compared to control. Pre- and post-challenge studies also revealed significantly better Hb, RBC, WBC, Hct, total serum protein, albumin, globulin, NBT assay, phagocytic and lysozyme activity in fishes fed dietary ginger at 10 g kg⁻¹ diet ($P < 0.05$). Histological sections of tissues of</p>	

the fishes fed ginger incorporated diet also showed better arrangement of the cells both in pre and post-challenge studies. The study suggested that a dietary level of ginger powder of 10 g kg⁻¹ diet is beneficial for the growth, survival and to enhance overall immunity of striped catfish juveniles

EVALUATION OF GROWTH PERFORMANCE OF GENETICALLY IMPROVED FARMED TILAPIA, *Oreochromis niloticus* (Linnaeus, 1758) IN BIOFLOC SYSTEM

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Sangita S. Wasave	Registration No.: FRRTD0160033
Year of thesis submission: 2020	
Name of the research guide: Dr. B. R. Chavan	Designation: Professor

The study was conducted to evaluate the effect of carbon sources, protein levels and feeding rates on growth performance and subsequent changes in water quality, fish body composition, production of microbial protein and digestive enzyme activity of GIFT fry in biofloc system. The fishes were stocked @ 250 nos m⁻³ in 110L capacity FRP tanks for 90 days. The C/N ratio was maintained at 15:1.

In experiment I, six carbon sources viz, sugar cane molasses(T₁), sugar(T₂), jaggery(T₃), wheat flour(T₄), wheat bran(T₅), rice bran(T₆) and control(T₀) were used as treatments with three replicates. The fishes were fed with a commercial feed containing 40% crude protein twice a day. The results showed that a significantly higher length gain, weight gain, specific growth rate, protein efficiency ratio, total plate count, digestive enzyme activity (amylase, lipase and protease activity), maximum crude protein of fishes and biofloc and lower apparent feed conversion ratio (AFCR) were recorded in T₆.

In experiment II, fishes were fed with commercial feed with six protein levels viz, 24, 28, 32, 36, 40, 44% and five feeding rates at 10, 8, 6, 4 and 2% of body weight using rice bran as a carbon source. The result showed that the length gain, weight gain and SGR of fry recorded in 32% protein level was at par with 36 % and 40% protein level and the feeding rate at 4% was at par with 6% feeding rate. Although AFCR was low at 2 % feeding rate, but the growth parameters showed better results at 4% feeding rate. The crude protein, crude fat percentage in fish and biofloc, the lipase and protease activity at 32% protein levels at 4% feeding rate were at par with those recorded at higher protein and feeding levels. All the water quality parameters were within the suitable range for rearing fishes.

MATURATION AND LARVAL DEVELOPMENT OF MANGROVE CLAM, *Polymesoda erosa* (solander1786)

Degree: Ph. D.	Subject: Aquaculture
Name of the Student: Varsha R. Bhatkar	Registration No.: FRRTM0190404
Year of thesis submission: 2022	
Name of the research guide: Dr. A. S. Pawase	Designation: Professor (CAS)

Gonadal maturation and induced spawning studies were carried out on one of the largest growing tropical mangrove clam species, *Polymesoda erosa*. Fortnightly collections were made from Aare-ware, Mirya and Waravade estuary around Ratnagiri coast of Maharashtra state for a period of over one year from Aug. 2017 to Oct. 2018. A total of 1358 samples were collected for reproductive biological studies. The GSI values revealed continuous breeding activities for male and female clams. Reproductive cycle showed low levels of spawning throughout the year with a peak between March to July (pre monsoon and monsoon). The gonadal development was categorised into six stages, viz. primordial, developing, maturing, ripe, partially spent and spent by morphological and histological methods. Gonadal maturation studies under laboratory conditions were also carried out to assess the effect of temperature and salinity on Condition Factor (CF), Gonad Index (GI) and Oocyte Diameter (OD) in two separate experiments each of 60 days duration. The CF was directly proportional to increased water temperature having highest value of 55.15 ± 1.81 at 32°C and lowest value of 27.4 ± 0.95 at 26°C . With respect to salinity, the lowest CF was observed in 10 ppt (29.40 ± 2.03) and highest (62.80 ± 1.51) in 30 ppt. Optimum temperature and salinity observed for CF was 32°C and 25 ppt respectively. The highest male GI value of 3.31 ± 0.26 was observed at 32°C and the lowest value observed was 1.11 ± 0.63 at 26°C . The highest female GI value 2.87 ± 0.30 was observed at 30°C , whereas, the lowest GI value 0.67 ± 0.10 was observed at 26°C . In case of salinity, GI value in male was the highest at 35 ppt (3.23 ± 0.22) and the lowest at 10 ppt (1.10 ± 0.10). Female GI values was highest in 25 ppt (3.27 ± 0.31) and lowest in 10 ppt (0.56 ± 0.11). The optimum temperature and salinity observed for GI was 30°C and 25 ppt respectively for both the sexes. With respect to temperature, the oocyte diameter was maximum of 79.37 ± 1.53 at 32°C . The minimum oocyte diameter 46.42 ± 0.14 was observed at 26°C . In salinity experiment, the highest oocyte diameter was recorded in 35 ppt (80.26 ± 1.22) and the lowest was recorded in 10 ppt (47.89 ± 2.08). Optimum temperature and salinity observed for oocyte diameter was 32°C and 25 ppt respectively. In all, three inducement trials were conducted. Thermal and salinity inducements could not reveal spawning in the both the sexes of clams. Serotonin inducement with immersion method with the concentration of 4 and 8 ppm resulted in the spawning of male, while the female clams responded to 8 ppm only. The predominant larval stages, viz. trochophore, 'D'-shape, pediveliger and spat were appeared within 10-12 h, after 30 h, on 22nd day and on 32nd day, respectively.

Microalgal diet, *Isochrysis galbana* was fed at a rate of 3,000-12,000 cells ml⁻¹ for the larval stages. Water parameters such as water temperature, pH and salinity were recorded as 23 – 24 °C, 7.9 and 28 – 30 ppt respectively during the larval rearing period.

STUDIES ON CULTURE OF DIFFERENT SEAWEED SPECIES AT RATNAGIRI COAST

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Amol Govindrao Rathod	Registration No.: FRRTD0150026
Year of thesis submission: 2022	
Name of the research guide: Dr. D.I. Pathan	Designation: Professor (CAS)

The experiments were conducted to evaluate the performance of two native seaweed species viz. *Gracilaria edulis* and *Gracilaria corticata* along with a commercial species *Kappaphycus alvarezii* using floating bamboo raft culture method during pre-monsoon and post-monsoon periods at Mirya Bandar, Ratnagiri, Maharashtra. During the pre-monsoon period, *Gracilaria edulis* showed a maximum daily growth rate (DGR) (0.1126 % day⁻¹) and plant yield (1.779 g day⁻¹) than the other two species in Experiment I. In Experiment II, *Gracilaria edulis* was selected and cultured at different stocking densities of 125 (T₁), 187.5 (T₂), 250 (T₃), 312.5 (T₄) and 375 (T₅) g/line. A stocking density of 187.5 g (T₂) gave the best DGR (3.75 ± 0.04 % day⁻¹) and plant yield (179.7 ± 9.47 g/line) which were found to be significantly better than those of other treatments (P < 0.05). Experiment III was conducted for culture of *Gracilaria edulis* maintaining a stocking density of 187.5 g/line at different spacing intervals of 5 (T₁), 10 (T₂), 15 (T₃), 20 (T₄) and 25 (T₅) cm per insertion. A statistically maximum DGR of 3.84 ± 0.01 % day⁻¹ and plant yield of 204.2 ± 3.99 g/line were recorded for a spacing interval of 15 cm (T₃) (P < 0.05). While during the post-monsoon periods, among the three species cultivated, *Kappaphycus alvarezii* recorded maximum DGR (0.1504 % day⁻¹) and plant yield (15.567 g day⁻¹) in Experiment I. For the Experiment II, *Kappaphycus alvarezii* was selected and cultured at different stocking densities of 375 (T₁), 500 (T₂), 625 (T₃), 750 (T₄) and 875 (T₅) g/line. A stocking density of 750 g/line (T₄) gave the maximum DGR (5.46 ± 0.01 % day⁻¹) and plant yield (1889.2 ± 30.87 g/line) than the others treatments (P < 0.05) with the exception of T₅ being similar (P > 0.05). Experiment III was conducted for the culture of *Kappaphycus alvarezii* by maintaining a stocking density of 750 g/line at different spacing intervals of 5 (T₁), 10 (T₂), 15 (T₃), 20 (T₄) and 25 (T₅) cm per loop. A statistically maximum DGR and plant yield of 5.35 ± 0.01 % day⁻¹ and 1641.2 ± 18.21 g/line were recorded respectively for a spacing interval of 20 cm (T₄) than the rest of the groups (P < 0.05) with the exception of T₅ being similar (P > 0.05). In laboratory study, the gel strength of carrageenan obtained was 53.6 ± 3.60 g cm² from *Kappaphycus alvarezii*, while in agar-agar it was 17.22 ± 0.43 and 13.00 ± 0.90 g cm² from *Gracilaria edulis* and *Gracilaria corticata* respectively.

NURSERY SEED REARING OF CATLA, *GIBELION CATLA* (HAMILTON, 1822) IN INDOOR BIOFLOC SYSTEM

Degree: Ph.D.	Subject: Aquaculture
Name of the Student: Miss Sonia	Registration No: FRRTD0190040
Year of thesis submission: 2022	
Name of the research guide: Dr. S.J. Meshram	Designation: Associate Professor(CAS)

The study was carried out for nursery rearing of catla, *Gibelion catla* in indoor biofloc system. In all two experimental trial of twenty days and sixty days were conducted for spawn and fry respectively in 100L HDPE circular tanks. Rice bran was used as the carbon source for manipulating C/N ratio. In Experiment-I, a factorial design (3 × 3) was performed to investigate the effect of C/N ratio (10, 15 and 20, first factor) and stocking density (3, 4 and 5 spawn L⁻¹, second factor) on *Gibelion catla* spawn nursery rearing in biofloc system in a completely randomized design with triplicates (totalling 27 experimental units). The spawn were fed with rice bran and groundnut oil cake (1:1). Each treatment was stocked with catla spawn of average length (6.7 ± 0.4 mm) and average weight (1.6 ± 0.2 mg). Water parameters showed that, increasing C/N ratio from 10 to 20 significantly (P<0.05) reduced total ammonia nitrogen (TAN), nitrite nitrogen (NO₂-N) and increased nitrate nitrogen (NO₃- N) in the water. The insignificant difference (P>0.05) and lowest final average length, average length gain, average weight gain and specific growth rate (SGR) were recorded in C/N ratio of 10 and 15 compared to C/N ratio of 20. Significant difference (P<0.05) in survival was observed with increasing C/N ratio. Increasing the fish stocking density resulted in higher mortality. However, higher number of fry produced was observed in the treatments with 3 and 4 spawn L⁻¹. Crude protein content increased significantly (P< 0.05) with increasing C/N ratio with higher content in C/N 20. No significant difference (P> 0.05) in proximate composition of biofloc was observed in different stocking densities groups. In Experiment-II, sixty days feeding trial was carried out to optimize the dietary protein level for fry in biofloc system. Post feeding trial fingerlings were challenged with *Aeromonas hydrophila* (1x 10⁷ cfu/ml), and blood parameters were analysed. The experiment consisted of four biofloc treatments with different dietary protein, T1 (20% CP), T2 (25%CP), T3 (30% CP) and T4 (35% CP) and clear water control without biofloc T0 (30% CP) each with four replicates. The average length (2.65± 0.00 cm) and average weight (0.21±0.01g) of catla fry were stocked at the rate of 3 fry per 10 L. C:N ratio of 20:1 was maintained in biofloc system. The biofloc treatments receiving lower protein diets upto 30% showed improved water quality compared to 35% CP receiving treatment and clear water. No significant difference (P>0.05) was observed in growth performance between 20%, 25% and 30% CP fed BFT tanks but was significantly higher (P<0.05) than T0 and T4. Survival rate showed no significant difference(P>0.05) among different groups. Relative percentage survival was significantly better (P<0.05) in biofloc group with highest in T3 after challenge study. Pre and post- challenge studies revealed significantly better ((P<0.05) RBC, WBC, Hb and Hct in fish reared in biofloc groups with highest in T3 (30% CP) group. No adverse histological changes were observed in the liver of the fish in different groups. The increase in number of goblet cells and microvilli length were observed in intestine histology of fish with increase in protein in biofloc groups. No significant difference (P>0.05) was observed in nutritional composition of biofloc and fish fed different protein diets in control and biofloc group

The present study revealed that the application of biofloc technology with C:N ratio of 20 at a stocking density of 4 spawn L⁻¹ could be recommended to increase the production of catla fry in indoor biofloc system. The protein diet of 30% CP can improve the growth performance of *Gibelion catla* fry in biofloc system with improved tolerance to environmental and pathogenic stress.

5. Extension Activities

A. The training programmes organized

1. By Dr. A. S. Pawase

1. **Title:** Brackishwater shrimp farming'
2. **Sponsorer:** Paid training
3. **Date and Duration:** 01.01.2020 to 05.01.2020
4. **Participant:** Farmers, number of farmers:10
5. **Schedule of training programme:** 15 theory classes, 07 practical classes and one field visit to operational farm.
6. **Special feature of the training programme:** The programme was organized for prospective and aspiring shrimp farmers of Konkan.



5. By Dr. B. R. Chavan

Sr. No.	Training/Workshop	Organizing Institute	Beneficiaries	Course Director / Coordinator / Convener	Duration (Days)	Dates	
						From	To
1	Model Training Course on Sustainable Development of Marine Fisheries	College of Fisheries, Shirgaon, Ratnagiri	15	Member	7 days	5/10/2009	12/10/2009
2	Freshwater fish culture at Primary School , Tandulwadi with financial assistance from MPSSM, Malkapur under the scheme rural livelihood implement program. Duration:	MPSSM, Malkapur , Buldhana	30	Member		8/3/2011	10/3/2011
3	Training program on Fish Culture in Cages	Marine Biological Research Station, Ratnagiri Funded by RGSTC	12	Coordinator	4 days	10/7/2012	13/7/2012
4	Training program on Freshwater fish and prawn Culture	Marine Biological Research Station, Ratnagiri	20	Member	5days	3/6/2014	7/6/2014
5	Training program on	Marine Biological Research Station, Ratnagiri	25	Member	5 days	18/2/2015	22/2/2015

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6	Øããñ ¼ãã 1ãã¼ãã ããèÊã ‡ãŠãñßã°ããè ,ãããã¼ã ¼ã Ô¼ãlãñ ãã è	Marine Biologica l Research Station, Ratnagiri	20	Member	5 days	23/3/201 5	27/3/201 5
7	Ecofriendly and Sustainable prawn farming and diversification of Aquaculture at Kadavai, Sangameshwar, Ratnagiri	Marine Biologica l Research Station, Ratnagiri funded by MPEDA	25	Coordina tor	4 days	23/3/201 5	27/3/201 5
8	State level training program on Freshwater prawn and fish farming	College of Fisheries. Ratnagiri.	22	convener	6 days	17/9/201 7	23/9/201 7
9	State level training program on Freshwater prawn and fish farming	College of Fisheries. Ratnagiri.	17	convener	5 days	21/11/20 17	25/11/20 17
10	Reservoir Fish Culture at Arjuna Dam, Pachal, Tal. Rajapur, Dist. Ratnagiri	College of Fisheries, Shirgaon and KVK (DBSKK V), Lanja, Ratnagiri.	20	Coordina tor	01 day	15/5/201 8	15/5/201 8
11	“Ornamental Fish Breeding, Rearing and its Management”	Departme nt of Zoology Shivaji Universit y, Kolhapur	200	Coordina tor	6 days	23/07/20 18	28/07/20 18.
12	All male tilapia seed production nursery rearing and growout	College of Fisheries, Shirgaon and	29	Coordina tor	02 days	2/8/2018	3/8/2018

	management	National Agriculture Bank, ATMA, and Nisarg Foundation, Raigad					
13	Modern Technologies in Freshwater Fish farming	College of Fisheries, Shirgaon	39	Coordinator	03 days	16/7/2019	18/7/2019
14	One day workshop on “ ईआँइःआँःआँःआँः १ःआँःआँः आँः आँःआँःआँःआँः आँः आँःआँःआँःआँः आँःआँःआँः आँःआँःआँःआँः ”	COF and Krishi Vigyan Kendra, Lanja, Ratnagiri	30	Coordinator	01 days	13/11/2019	13/11/2019
15	Modern Technologies in Freshwater Fish farming	COF, Shirgaon	40	Coordinator	03 days	28/11/2019	30/11/2019

6. By Dr. G. S. Ghode

1. Title:

One Month Skill Development Certificate Course on “**Aqua-clinic and Aquapreneurship Development Program**” at College of Fisheries, Shirgaon, Ratnagiri, Maharashtra

2. Sponsorer: National Institute of Agricultural Extension Management (MANAGE), Hyderabad & National Fisheries Development Board (NFDB), Hyderabad

Budgetary Provision: Rs. 9.60 lakhs

3. Date : 7th January 2020 to 3rd February 2020

Duration: 28 days

Participants: Graduate students holding degree in agricultural & allied sciences and life sciences.

4. Number of participants: 24

5. Schedule of the training programme:

It was a skill development program for imparting practical hands-on training in Aqua-clinics and Aquapreneurship to graduate students so that they develop capabilities required to cater to needs of rising aquaculture sector. Participants were acquainted with recent advances in fish culture technologies, diagnostics and feed and water management tools.



Figure 1. Inauguration of AC & ADP skill Development Program

4. . **Title:** बायोफ्लॉक तंत्रज्ञान: मूलभूत ज्ञान

Sponsorer: Paid training

Name of co-ordinators: Dr. S. J. Meshram, Dr. R. M. Tibile, Dr. S. S. Wasave

2. **Date and Duration:** 07.03.2022 to 11.03.2022

3. **Participant:** Farmers, number of farmers:20

4. **Schedule of training programme:** 11 theory classes, 14 practical classes and one field visit to operational farm.

5. **Special feature of the training programme:** The programme was organized to provide basic knowledge of biofloc technology to fish farmers of Konkan .



5. **Co-ordinators:** Dr. R.M. Tibile, Dr. S.S. Wasave, Dr. V.R. Bhatkar and Mrs.A.N. Sawant

1. **Title:** Ornamental fish breeding, rearing and management

2. **Sponsorer:** Paid training

3. **Date and Duration:** 23.03.2023 to 25.03.2023

4. **Participant:** Farmers, Number of farmers:06

5. **Schedule of training programme:** 14 theory classes, 05 practical classes
6. **Special feature of the training programme:** The programme was organized for skill development of ornamental fish farmers.



6. Co-ordinator: Mrs.A.N. Sawant

1. **Title:** Ornamental fish breeding, rearing and management
2. **Sponsorer:** Paid training for UNDP-GCF Beneficiaries
3. **Date and Duration:** 20.06.2023 to 21.06.2023
4. **Participant:** Farmers, Number of farmers:16
5. **Schedule of training programme:** Practical based programme 13 practical classes
6. **Special feature of the training programme:** The programme was organized for skill development of ornamental fish farmers and breeders.



B.Seminar/Symposia/Conference/Workshop Organized

Title:

Sponsorer:
 Date and duration:
 Participants: (Nature of the participation and no. of participants)
 Schedule of the Seminar/Symposia/Conference/Workshop:
 Key Note Speakers along with their topic of speech
 No. of papers presented
 Whether papers published in abstract/full length form? If so provide the details in bibliographical format.
 One photograph

C. Farmer Melawa Organized

Title:
 Sponsorer:
 Date and duration:
 Participants: (Nature of the participation for eg. Farmers, Govt official, Academician etc and no. of participants)
 Name of the speakers along with their topics
 One photograph

**D. Radio/TV Talks delivered by the staff members of the Department/Section:
 Provide the relevant details such as name of the person, topic, where and when delivered etc.**

1.Name of staff member: Dr. Anil S. Pawase		
Sr. no.	Topic	Broadcast Date
1.	Medicinal Properties of fish	23.03.96
2.	Freshwater prawn farming	15. 06.96
3.	Fishing Craft accessories and care	17.08.96
4.	Fishing with traps	15.01.97
5.	Prawn processing and preservation	08.11.97
6.	Fish Culture in running waters	09.05.98
7.	Why ban on monsoon fishing?	09.08.03

Sr no	Topic	Date of Broadcast	Place of Recording / Broadcasting	Year
1	Ornamental fish farming	20/03/2000	Ratnagiri	2000
2	Rules for fabrication of fishing vessel	08/02/2002	Ratnagiri	2002
3	Mase mari naukanche apaghat kase talavet	15/11/2002	Ratnagiri	2002
4	Hygiene and sanitation in fish market	21/06/2002	Ratnagiri	2002
5	Mase mari naukanche apaghat talaNyaache upay	31/10/2003	Ratnagiri	2003
6	Hygiene and sanitation in fish market	30/01/2004	Ratnagiri	2004
7	Methods of preparation of Fish by-product	17/04/2004	Ratnagiri	2004
8	Effects of exploited fisheries	08/05/2009	Ratnagiri	2009
9	Fish cage culture	16/04/2010	Ratnagiri	2010
10	Catla and prawn integrated farming	27/05/2011	Ratnagiri	2011
11	Reservoir fish farming by involving shelf help group	06/01/2012	Ratnagiri	2012
12	Fish farming in farm ponds	10/08/2012	Ratnagiri	2012

13	Reservoir fish farming : present status and future prospectus	19/07/2013	Ratnagiri	2013
14	Reservoir fish farming by involving shelf help group	12/12/2014	Ratnagiri	2014

TV Programme by Dr. S. J. Meshram

Topic	Date of Broadcast	Place of Recording / Broadcasting	Year
TV Programme			
1) Freshwater fish culture in pond (Live phone in programme)	04/03/2006	Mumbai Doordarshan	2006
2) Freshwater fish farming	12/03/2010	Pune Doordarshan	2010
3) Rice-cum-fish culture	03/08/2015	Mumbai Doordarshan	2015
4) Nursery Rearing of IMC seed in farm pond (Live phone in programme)	31/08/2017	Mumbai Doordarshan	2017

Radiotalk by Dr. G. S. Ghode			
Sr. No	Topic	Date	Place
1.	Integrated Fish farming	3/7/2009	Ratnagiri
2	Freshwater Prawn farming	15/4/2011	Ratnagiri
3	Diseases in shrimp farming and prophylactic methods	6/08/2019	Ratnagiri

Radiotalk by Dr. R. M. Tibile			
Topic	Date of Broadcast	Place of Recording / Broadcasting	Year
Radio Talk			
Neemkharya Panyateel Kolambi Sanvardhan: Talawanchi Purvatayari	2006	AIR, Ratnagiri	2006
Godya Panyateel Matsyasheti	2008	AIR, Ratnagiri	2008
Carp Mashyanche Botukali Utpadan	2010	AIR, Ratnagiri	2010
Khekada Sanwardhan: Khadya Vyavasthapan	2011	AIR, Ratnagiri	2011

Radiotalk by Dr. S. S. Wasave

Topic	Date of Broadcast	Place of Recording / Broadcasting	Year
Godya panyateel kolambi beej nirmiteet pani ani khadyache vyavasthapan	September	SAAM TV Marathi	2008
Kakai sanvardhan ya malet – sanvardhanacya vividha padhati	16/03/2007	AIR, Ratnagiri	2007
Kolambi shetichi purvatayari	28/09/2007	AIR, Ratnagiri	2007
Kolambi shetit panyache vyavashtapan	18/09/2009	AIR, Ratnagiri	2009
Integrated fish farming	-	AIR, Ratnagiri	2010

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‡ãŠãñßã°ããè Ôãàìã£ãÃ¶ããÔããÿãè 1ãìãÃ ;ã¼ããÀãè-¼ãñ;ìãã;ããÃ	03/12/2012)	AIR, Ratnagiri	2012
Shobhivant matsyapalan vyavsay sandhi	28/08/2015	AIR, Ratnagiri	2015
Biofloc technology for shrimp farming	4/09/2021	AIR, Ratnagiri	2021
°ãã¼ããñ'Ëãù‡ãŠ ;ããã—ãã¶ã: ½ã; Ô¼ã°ããè•ã Ôããøããñ'ã¶ã ,ãããããã ì¼ãìãÔ©ãã'ã¶ã	October 2022	AIR, Ratnagiri	2022

D. **Farmer-Scientist Forum:** The name of the form along with the in charge of the forum, members of the forum (name, address and phone number) and activities of the forum be provided here.

E. **Other Extension Activities:** Provide the details of any other notable extension activities performed by the Department/Section
 Mobile app- Ornamental fish culture
 Mobile app- Brackishwater shrimp farming

G. **Publications:** Provide the details of the following publications published by the Department/Section in bibliographical form

i) Books:

By B. R. Chavan

Sr.No	Title of Books	Publisher/Institute
1	Godya panyateel Pinjaryateel Matsya saVradhan aani Vevsthapan: ISBN:978-93-5300-001-1	Director of Extension Education, DBSKKV, Dapoli, Ratnagiri and Member Secretary, RGSTC, Mumbai, 2018
2	Shetatalyateel Matsya saVradhan aani Vevsthapan ISBN:978-93-5300-125-4	Director of Extension Education, DBSKKV, Dapoli, Ratnagiri, 2018
3	Abstract Book: Empowerment of Rural Communities through Aquaculture. ISBN: 978-93-5300-091-2.	Director of Research, DBSKKV, Dapoli, Member Secretary, RGSTC, Mumbai and Associate Dean, COF, Ratnagiri. 2018

4	Special issue: Empowerment of Rural Communities through Aquaculture. ISSN 2231-2137.	Wiz craft publication, Deepak Nanaware, Editor-in-Chief, 129/498, Vasant Vihar, Near Old Pune Naka, Solapur-413001 (Maharashtra, India). 2018
5	Godyapaanyateel Kolambe aani Matsya sheti	Associate Dean, COF, Ratnagiri. 2017
6	Book of Abstract: Challenges and opportunities for Sustainable Fisheries and Aquaculture Development, COSFAD-2019	Director of Extension Education, DBSKKV, Dapoli, Ratnagiri. 2019
7	Godya Panyateel Matsyasauvardhan: Adhunik Tantradhyan-2019. ISBN: 978-81-938864-5-8.	Director of Extension Education, DBSKKV, Dapoli, Ratnagiri. 2019
8	Book on Question Bank of Aquaculture	Director of Extension Education, DBSKKV, Dapoli, Ratnagiri. 2020

Title	Author	Publisher Name	Year
Freshwater Aquaculture (AQC 123)	S. J. Meshram	Practical Manual (DBSKKV)	2017
Culture of fish food food organism (AQC 235)	V. R. Bhatkar	Practical Manual (DBSKKV)	2017

ii) Booklet/bulletin

iii) Folders/leaflets

Folders	Authors	Publisher	Year
10 - leaflets on Freshwater Aquaculture	P. E. Shingare, S. J. Meshram and S. S. Dhane	Leaflets - DBSKKV	2009-10

LEAFLETS WRITTEN FOR EXTENSION			
1.	Pathan D.I., Singh H., Sawant N.H., & Tibile R.M.	Ôã½ãìªÆ ãšã#ãšfÃ (ìãã#ãìãš:ã) ÔããìãÆã¶ã	NATP 2001
2.	Pathan D.I., Ranade A.M., Singh H., Sawant N.H., Deolalikar A.V. & Tibile R.M.	#ãšã#ãšfÃ ìãñ!ããè ¾ãìãÔìããè ÔãìÀìãã!ã	ATMA 2002
3.	Pathan D. I.,	Farming of mussels – A story	ATMA 2002

Dr. G.S. Ghode: Training Manual prepared for training on “One Month Skill Development Certificate Course on “**Aqua-clinic and Aquapreneurship Development Program**” at College of Fisheries, Shirgaon, Ratnagiri, Maharashtra

Sponsorer: National Institute of Agricultural Extension Management (MANAGE), Hyderabad & National Fisheries Development Board (NFDB), Hyderabad

Budgetary Provision: Rs. 9.60 lakhs

Date : 7th January 2020 to 3rd February 2020

Duration: 28 days

vi) Journal Research papers

vii) Full length research papers published in Proceedings of Seminar/Symposia /Conference/Workshop

G. Publications:

1. Publications of Dr. S. D. Naik

Sr. No	Name of article	Date of publication	Name of Publication	IBSN No.
1	Purse-seining off Ratnagiri Boon for some but bane of Rampani Men	1986	<i>Fishing Chimes</i> :6(7):15-17.	0971-4529
2	Puffer menace to the Fishing Gear of South Konkan Coast.	1993	<i>Fishery Technology</i> : 178-179	0015-3001
3	Observation of large scale destruction of fishing gear by the pufferfish(Family – Tetraodontidae) along the southkonkan coast.	1998	<i>Indian Journal of Marine Sciences</i> : 27: 421-425	0379-5136
4	Biological observations on the pufferfishes of southkonkan coast with special reference to the net-damaging species <i>Lagocephalus spadiceus</i> Osteichthytes, Tetraodontidae	1998	<i>Indian Journal of Marine Sciences</i> : 27: 421-425	0379-5136
5	Novel seed acclimatisation system: Key to successful shrimp farming along the south konkan coast of Maharashtra.	1999	<i>Fishing chimes</i> :19(9):16-17	0971-4529
6	Occurrence of Sea horse fish along the coastal waters of	2001	<i>Asian Journal of Environmental</i>	0972-

	Ratnagiri (west coast of India).		<i>Biotechnology</i> , Aligarh : 3(3):227-229	3005
7	Maintenance and Breeding of Seahorse <i>Hippocampus kuda</i> in marine aquarium.	2002	<i>Ecology, Environment & Conversation</i> :.8(1):69-72	0971-765 X
8	Mass culture of Goldfish, <i>Carrasius auratus</i> round the year by induced breeding.	2002	<i>Journal of Maharashtra Agricultural University (JMAU)</i> :8(1):69-72	0378-2395
9	Studies on the acceptance of coloured feed by some aquarium fishes	2003	<i>Ecology, Environment & Conversation</i> : 9(1):65-67 (Best paper award)	0971-765 X
10	Seed production trial of Banana prawn, <i>Fenneropenaeus merguensis</i> on small scale in indoor hatchery.	2003	<i>Journal of Maharashtra Agricultural University (JMAU)</i> :27(3):296-298	0378-2395
11	Application of fisheries techniques for conservation and rehabilitation of depleting fish stock along the coast of Maharashtra.	2006	<i>Ecology, Environment & Conversation</i> :12(2):307-310	0971-765 X
12	Impact of mechanised fishing on coastal fisheries resources of konkan coast of Maharashtra	2006	<i>Ecology, Environment & Conversation</i> :12(2):311-314	0971-765 X
13	Prospects of mudcrab farming along the Konkan coast of Maharashtra	2009	<i>Ecology, Environment & Conversation</i> :15(3):663-666	0971-765 X
14	Growth performance of different formulated aquarium fish feed on freshwater prawn juvenile	2009	<i>Ecology, Environment & Conversation</i> :15(3):677-679	0971-765 X
15	Studies on growth and maturity of Goldfish, <i>Carassius auratus</i> using different lipid sources	2009	<i>Ecology, Environment & Conversation</i> :15(3):641-645	0971-765 X
16	Food and feeding habits of Mudcrab, <i>Scylla spp.</i> Of Ratnagiri coast of Maharashtra	2009	<i>Journal of Ecology and Fisheries</i> : 2(1):43-50	0974-6323
17	Comparative osteology of the pufferfishes (Family:Tetraodontidae)of Maharashtra	2009	<i>Journal of Ecology and Fisheries</i> : 2(1):105-112	0974-6323
18	On the aspect of seed production and prospect for brackishwater culture of Pearl spot, <i>Etroplus</i>	2009	<i>Journal of Ecology and Fisheries</i> : 2(1):37-42	0974-6323

	<i>suratensis</i>			
19	Catch particulars of Mudcrab, <i>Scylla spp</i> of Ratnagiri, Maharashtra	2009	<i>Aquacult:10(1):17-25</i>	0972-2262
20	Contribution to the biology of the mudcrab, <i>Scylla serrata</i> of Ratnagiri, Maharashtra	2009	<i>Aquacult:10(1)73-79</i>	0972-2262
21	Studies on effect of ethynyl-estradiol on 30 days old Rosy barb(<i>Puntius conchonius</i>)	2009	<i>Aquacult:10(1)35-39</i>	0972-2262
22	Length-weight relationship in <i>Nemipterus japonicus</i> of Ratnagiri coast along Maharashtra.	2011	<i>Indian Journal of applied & pure biology:26(1):79-84</i>	0970-2091
23	Length frequency analysis of <i>Nemipterus japonicus</i> along the Ratnagiri coast off Maharashtra.	2011	GEOBIOS: 38(4), 229 – 232	0251 - 1223
24	Reproductive biology of Indian Mackerel, <i>Rastrelliger kanagurta</i> off Ratnagiri coast, Maharashtra, India.	2013	<i>Discovery Science: 3(9):24-26</i>	2278-5485
25	Occurrence of Ocean sun fish <i>Mola mola</i> (Linnaeus) in the coastal waters off Ratnagiri, Maharashtra.	2013	<i>Fishing Chimes:32(12):55.</i>	0971-4529
26	The mudcrabs (Family: Portunidae) of the south konkan coast of Maharashtra	2013	<i>Ecology, Environment & Conversation:19(3):109-114</i>	0971-765 X
27	Reproductive Biology of Green Crab, <i>Scylla tranquibarica</i> (Fabricius,1897) found in Ratnagiri Coast, Maharashtra, India.	2013	Paper presented in the International symposium on mudcrab aquaculture and management at RGCA, Nagapattinum. (Appreciation award)	-- --
28	Length frequency analysis and length-weight relationship of ribbonfish, <i>Lepturacanthus savala</i> (Cuvier,1829) off Ratnagiri coast, Maharashtra.	2013	<i>International Journal of Fisheries and Aquatic Studies: 1(2):25-30</i>	2347-5129 (NAAS rating– 3.99)
29	Comparative efficiency of Mudcrab Fishing Methods in and around Ratnagiri, Maharashtra.	2013	<i>Aquacult: vol 14(1 &2):25 to 34.</i>	0972-2262

30	Impact of self Employment Training programmes “ Value Added Fish Product on the woman self-Help Group of Konkan Coast of Maharashtra	2014	Paper presented in the National seminar on “ <i>Global Opportunities in Agriculture Enterprenuership/Business</i> at Pune (Best Poster presentation award)	----
31	Feeding biology of the Indian mackerel, <i>Rastrelliger kanagurta</i> (Cuvier,1817) off Ratnagiri coast, Maharashtra, India	2014	<i>Eco.Env.& Cons.</i> 20(3); pp(1147-1152)	0971-765X (NAAS rating – 5.02)
32	Length frequency analysis of Indian mackerel, <i>Rastrelliger kanagurta</i> (Cuvier, 1817) off Ratnagiri Coast, Maharashtra, India	2014	<i>Eco.Env.& Cons.</i> 20(4); pp(1549-1551)	0971-765X (NAAS rating – 5.02)
33	Morphometric and Meristic studies of Indian Mackerel, <i>Rastrelliger kanagurta</i> (Cuvier,1817) off Southern coast of Maharshtra, India.	2014	<i>Eco.Env.& Cons.</i> 20(4); pp(1705-1708)	0971-765X (NAAS rating – 5.02)
34	Mangrove areas of South Konkan Coast of Maharashtra	2015	<i>Proceedings of International Conference on “Ethical Prospects: Economy, Society and Environment” (ICEPES E-2015 (Best Paper Presentation award)</i>	ISBN 978-93-83046-46-1
35	Morphological characters and morphometric relationship of pony fish, <i>Leiognathus splendens</i> (Cuvier,1829) off Ratnagiri coast, Maharashtra, India.	2015	<i>International Journal of Sciences and applied Research</i> , 2(7): 115-125.	2394-2401
36	Backyard hatchery operation for seed production of Mudcrab, <i>Scylla tranquibarica</i>	2015	<i>Global Journal of Multidisciplinary studies</i> , 4(12):405-412	2348-0459
37	Reproductive biology of Pony fish, <i>Leiognathus splendens</i> (Cuvier,1829) off Ratnagiri coast, Maharashtra, India.	2015	<i>Global Journal of Multidisciplinary studies</i> , 4(12):389-400	2348-0459
38	Histology and Ova diameter study of Pony fish ,	2015	<i>Global Journal of Multidisciplinary</i>	2348-0459

	<i>Leiognathus splendens</i> (Cuvier,1829) off Ratnagiri coast,Maharashtra .		<i>studies,5(1):44-55</i>	
39	Age, growth and mortality studies of Indian squid, <i>Uroteuthis (Photololigo) duvauceli</i> (d'Orbigny) along Ratnagiri Coast of Maharashtra, India	2015	<i>Indian journal of Geo-Marine Sciences, 44(1): 93-96.</i>	0379-5136
40	Food and feeding habit of pony fish, <i>Leionathus splendens</i> (Cuvier,1829) off Ratnagiri coast,Maharashtra.	2016	<i>International Journal of Scientific &Engineering Research,7(9):122-133</i>	2229-5518
41	Length frequency analysis and length-weight relationship of pony fish, <i>Leionathus splendens</i> (Cuvier,1829) off Ratnagiri coast,Maharashtra.	2016	<i>International Journal of Scientific &Engineering Research,7(9):239-249</i>	2229-5518
42	Biometric studies on Greater lizard fish <i>Saurida tumbil</i> (Bloch, 1795) along Ratnagiri coast of Maharashtra.	2016	<i>Indian journal of Geo-Marine Sciences, 45(1): 1310-1316.</i>	0379-5136
43	Backyard hatchery seed production of mudcrab	2017	"Sampada" published by MCCIA,Pune 72(1) :32-33.	2455-2097
44	Allometric relationship of shortneck clam <i>Paphia malabarica</i> (Chemnitz, 1782) along Aare-Ware rocky shore of Ratnagiri,Maharashtra	2017	<i>Indian Res. J. Genet. & Biotech; 9(1) : 66-72</i>	2277-1913
45	Proximate composition and fatty acid profiling of Indian mackerel (<i>Rastrelliger kanagartha</i>) off Ratnagiri,west coast of India	2017	<i>Int.J.Pure App.Biosci. 5(4): 920-924.</i>	2320-7051
46	Study on morphometric identification of some finfish Seed along the kasarveli estuary of Ratnagiri coast of Maharashtra.	2017	<i>Contemporary research in India.special Vol. 7(4): 183-187</i>	2231-2137
47	Studies on growth and stock assessment of <i>saurida tumbil</i> (bloch, 1795) from Ratnagiri coast, india	2018	J. Exp. Zool. India 21(2) : 695-699,	0972-0030
48	Effect of different stocking densities on growth and reproductive performance of	2018	<i>Contemporary research inIndia.special issue :23-27.</i>	2231-2137

	platy fish, <i>Xiphophorus maculatus</i> (gunter,1866)			
49	Tilapia and shrimp Integrated Culture: Way to improved production, significant reduction of organic load and reduction in Disease outcomes.(Review)	2018	<i>Contemporary research inIndia.special issue :23-27.</i>	2231-2137
50	Effect of different feeding strategies on growth and survival rate of newborn Swordtail , <i>Xiphophorus helleri</i> (Heckel,1848)	2018	<i>Contemporary research inIndia.special issue :23-27.</i>	2231-2137
51	Investigations on the prevalence of important viral pathogens in selected crustaceans of Ratnagiri	2018	<i>Contemporary research inIndia.special issue :23-27.</i>	2231-2137
52	Ecosystem approach for enterprenuership development through mudcrab rearing inmangrove area of south konkan coast of Maharashtra	2018	<i>Contemporary research inIndia.special issue :23-27.</i>	2231-2137
53	Isolation of acid and pepsin soluble collagens from the skin of Indian mackerel <i>Rastrelliger kanagurta</i> (Cuvier,1817)	2018	<i>Journal of Entomology and Zoology Studies; 6(2): 2508-2511.</i>	2349-6800
54	Mudcrab Culture Can Earn Foreign Currency for Konkan Region	2018	<i>Advances Agricultural Research & Technology Journal ;II (2): 189-192.</i>	2581-3749
55	Microorganisms in maintaining Carbon/Nitrogen (C/N) ratio in Intensive Aquaculture System : A Review	2018	<i>International Journal of Tropical Agriculture;36(4):843-849</i>	0254-8755
56	Proximate composition and growth study of Green Mussel <i>Perna viridis</i> (L) from Mirya creek in Ratnagiri,Maharashtra,India.	2018	<i>Contemporary research inIndia.special issue :82-87.</i>	2231-2137
57	Effects of egg white and sodium ascorbate on gelation properties on lesser sardine (<i>Sardinella spp.</i>) surumi.	2018	<i>Journal of Entomology and Zoology Studies 6 (2), 2504-250</i>	2349-6800
58	Standardization of stocking density of <i>PUNTIUS SARANA</i> (hamilton, 1822) spawn in plastic lined ponds in south konkan agro climatic zone	2020	J. Exp. Zool. India(23), Supplement 1 : 771-773,	0972-0030
59	Effects of pomegranate peel extract on gelation	2020	J. Exp. Zool. India (23), Supplement1 : 811-817	0972-0030

	characteristic of lesser sardine (<i>Sardinella spp.</i>) surimi			
60	Effect of nutritional quality on frozen stored surimi prepared from lesser sardine (<i>Sardinella spp.</i>) added with different natural phenolic compounds.	2020	J. Exp. Zool. India (23), Supplement1 : 855-859	0972-0030
61	Role of Rice cum fish culture as an additional source of income in Konkan region.	2020	J. Exp. Zool. India (23), Supplement1 : 961-963	0972-0030
62	Role of biofloc systems: A review	2020	J. Exp. Zool. India (23), Supplement1 : 903-906	0972-0030
63	Growth performance of GIFT tilapia (<i>Oreochromis niloticus</i>) fry in biofloc system using different carbon source	2020	<i>International Journal of Fisheries and Aquatic Studies</i> : 8(4):206-211	2347-5129
64	Length-weight and morphometric relationship in tiny shrimp, <i>parapenaeopsis styliifera</i> (edward, 1837) off ratnagiri coast, maharashtra, india	2020	<i>Contemporary research in India</i> . 10 (3) :92-95.	2231-2137
65	Effect of stocking density on growth performance, plankton abundance, body composition and haematological parameters of <i>Etroplus suratensis</i> (Bloch, 1790)	2021	Aquaculture research	1355-557X
66	Quality changes in Ready-to-eat fish spread prepared from low cost croaker fish (<i>Otolithus spp.</i>) and Natural Ingredients	2021	Fishery technology (58):214-218	0015-3001 (NAAS rating – 5.82)
67	Algal-bacterial Interventions as a management tool for next-generation aquaculture sustainability	2022	Journal of Environmental Biology 43(4):485-497	0254-8704 (NAAS rating- 6.78)
68	Development of soup powder from hooded oyster <i>Saccostrea cucullata</i> and its storage study	2022	J. Exp. Zool. India 25(1), :673-681	0972-0030 (NAAS rating– 5.51)
69	Novel Product: Development of Ready-To-Eat fish spread from low cost fish	2022	J. Exp. Zool. India (25), : 1069-1072	0972-0030 (NAAS rating– 5.51)

70	Otolith Morphology: Aid to Species Variations of Fishes of Family Leiognathidae	2022	J KrishiVigyan,11(1): 256-260	2319-6432 (NAAS rating - 4.55)
71	Hematological responses in catla, <i>Gibelion catla</i> against <i>Aeromonas hydrophila</i> fed with different dietary protein in biofloc system	2023	J.Exp.Zool.India 26(1): 949-956	0972-0030 (NAAS rating- 5.51)
72	Seasonal changes in feeding habit of <i>Johnius elongates</i> (Mohan, 1976) sciaenid species from Ratnagiri coast, Maharashtra, India	2023	J.Exp.Zool.India 26(1): 707-711	0972-0030 (NAAS rating- 5.51)

3. Publications of Dr. A. S. Pawase

Sr. No.	Author/s	Title of the paper	Journal	Volume, page number, year
1	A.S. Pawase, A.S. Kulkarni, P.H. Mugaonkar, S.M. Wasave & S.R. Kovale	Possibilities of sea ranching in Konkan, Maharashtra.	J. Aqua. Biol.	21(3) : 83-86, 2006
2	Wani, Sabina, G. B. Wani, S. T. Indulkar & A. S. Pawase	Evaluation of suitable feed for rearing of Indian Medaka, <i>Oryziasmelastigma</i> (McCleand, 1839).	Annals of Biology	25 (2): 175-179, 2009
3	P.A. Patil, R.M. Tibile, A.S. Pawase & Gajanan Ghode	Growth and survival of Angel fish, <i>Pterophyllum scalare</i> (Schultze, 1823) fry reared at different stocking densities.	J. Env. Bio-Sci.,	29(1):167-172, 2015
4	Pawase A.S., Metar S.Y., Sawant M.S., Barve S.K. Akhade R.R. and Pai, R.	Stock Assessment of white fish, <i>Lactarius lactarius</i> (Bloch and Schneider, 1801) along Ratnagiri Coast of Maharashtra, India	Indian Journal of Geo-Marine Sciences	44(1):17-19, 2015
5	S.S. Balsare, H.S. Dhaker, A.S. Pawase,	Effects of dietary protein and lipid levels on growth, feed	Indian J. Anim. Res	B-3288:1-7, 2016

	V.R. Joshi, S.A. Mohite & R.H. Rathod	utilization and body composition in juvenile goldfish, <i>Carassius auratus</i>		
6	H. Mudasir, M.S. Sawant, R.A. Pawar, A.S. Pawase & F.A. Bhat	Stock Identification of <i>Nemipterus japonicus</i> along West Coast of India using RAPD Markers.	SKUAST Journal of Research	18(2): 130-137, 2016
7	M. M. Bhosale, R.R. Mugale, R.A. Pawar, M.S. Sawant & A.S. Pawase	Multivariate techniques to differentiate Portunid Crabs (<i>Charybdis feriatus</i> , <i>Portunus pelagicus</i> and <i>Portunus sanguinolentus</i>) from Ratnagiri coast, India: A comparative study,	J. Exp. Zool. India	19(2) 743-749, 2016
8	Khot, M, Jaiswar, A. K. and A.Pawase	First Record of <i>Ozius tuberculosus</i> H. Milne Edwards (Crustacea: Decapoda : Brachyura) from Maharashtra, West Coast of India, with Notes on Taxonomy.	Biosystematica	10(1&2):33-37, 2016
9	Bhoy, P. C., Pawase, A. S. , Pai, R., Sawant, M. S., Indulkar, S. T., Pawar, R. A. and Swain S.	Species Composition of freshwater prawn juveniles in river Amba Raigad district of Maharashtra.	Journal of Indian Fisheries Association	44 (2): 31-36, 2017
10	P. A. Patil, R. M. Tibile, G. S. Ghode & A. S. Pawase,	Growth performance of angelfish, <i>Pterophyllum scalare</i> (Schultze, 1823) fry reared at different stocking densities with under-gravel filtration system.	J. Exp. Zool. India	20(2) 1001-1007, 2017
11	S. Belsare, H.S. Dhaker, A. Pawase, V. Joshi, S. Mohite & S. Shelke	Effect of Dietary Carbohydrate - Lipid Ratio on Growth, Body Composition and Digestive Enzyme Activities of Juvenile Goldfish (<i>Carassius auratus</i>).	Animal Nutrition and Feed Technology	17 : 43-53, 2017
12	A.S. Pawase, S.Y. Metar, M.S. Sawant, R.R. Akhade	Studies on growth, mortality and stock assessment of Indian mackerel, <i>Rastrelliger</i>	Indian Journal of Geo-Marine Sciences	46(11):2382-2385, 2017

	and R. Pai,	<i>kanagurta</i> (Cuvier, 1817) from Ratnagiri coast of Maharashtra, India.		
13	U. R. Gurjar, M.S. Sawant, S. Takar, R.A. Pawar, V.H.Nirmale, and A.S. Pawase	Biometric analysis of white sardine, <i>Escualosa thoracata</i> (Valenciennes, 1847) along the Ratnagiri coast, Maharashtra, India	Journal of Experimental Zoology India	20(2):845-849, 2017,
14	U. R. Gurjar, M.S. Sawant, R.A. Pawar, V.H.Nirmale, A.S. Pawase and S. Takar	A study of food and feeding habit of white sardine, <i>Escualosa thoracta</i> (Valenciennes, 1847) along the Ratnagiri coast, Maharashtra	Journal of Experimental Zoology India	20(2):755-762, 2017
15	M. M. Bhosale, R.A. Pawar, M.S. Sawant & A.S. Pawase	Species differentiation of deep sea crabs (<i>Charybdis feriatus</i> , <i>Portunus pelagicus</i> and <i>P.sanguinolentus</i>) using conventional morphometric data off Ratnagiri Coast, India	Journal of Fisheries and Life Sciences	2(1): 35-39, 2017
16	U. R. Gurjar, M.S. Sawant, R.A. Pawar, V.H.Nirmale, and A.S. Pawase	Reproductive biology and fishery of the white sardine, <i>Escualosa thoracata</i> (Valenciennes, 1847) from the Ratnagiri coast, Maharashtra	Indian Journal of Geo-Marine Sciences	47(12):2485-2491, 2018
17	M. M Bhosale, RA Pawar, MP Bhendarkar, MS Sawant and AS Pawase	Truss based morphometric approach for the analysis of body shape in Portunid crabs (<i>Charybdis feriatus</i> , <i>Portunus pelagicus</i> and <i>P. sanguinolentus</i>) along Ratnagiri coast, India	Indian Journal of Entomology and Zoology Studies	6(2): 2641-2648, 2018
18	S. K. Hundare, D. I. Pathan, A. S. Pawase , R. K. Pai, R. M. Tibile, A. B. Ranadive	Use of fermented Azolla as fishmeal substitute in the Tilapia fry diet	Contemporary Research in India	62-67, 2018
19	Sagarika Swain, A.S. Pawase , RK Pai, RM	Effect of ginger (<i>Zingiber officinale</i> Roscoe) incorporated	Journal of Entomology and Zoology Studies;	6(3): 1094-1098, 2018

	Tibile, ST Indulkar and RA Pawar	diet on growth performance of striped catfish, <i>Pangasianodon hypophthalmus</i> (Sauvage, 1878)		
20	Mayura Khot, P. Sivaperumal, Neeta Jadhav, S. Chinnaesakki, S.V. Bara, Ravi Pazhayath M., S.K. Chakraborty, Anil Pawase , A.K. Jaiswar	Baseline radionuclide concentration in selected marine organisms around the coastal areas of Ratnagiri and Sindhudurg districts, west coast of Maharashtra, India	Marine Pollution Bulletin	135 (2018) 1051–1054, 2018
21	Mayura Khot, Sivaperumal, Neeta Jadhav, S.K. Chakraborty, Anil Pawase and A.K. Jaiswar	Diversity and composition of phytoplankton around Jaitapur coast, Maharashtra, India	Indian Journal of Geo-Marine Sciences	47(12):2429- 2441, 2018
22	Sana K M Patel, S.T.Indulkar, Abdul Lateef AH Shaikh, M.S. Sawant, A. S. Pawase and R. K. Pai	Effect of organophosphate pesticide, ethephon on serum biochemical parameters of freshwater ornamental fish rosy barb, <i>Pethia conchonicus</i> (Hamilton, 1822)	Journal of Entomology and Zoology Studies;	6(5):727- 731, 2018
23	A. S. Pawase, G. S. Ghode, R. M. Tibile, D. I. Pathan, K. S. Sawant, B. R. Chavan, S. J. Meshram, V. R. Bhatkar, V. K. Patil, A. D. Rane, P. M. Haldankar and T. Bhattacharyya	Boosting fishermen's Income by brackishwater shrimp culture	Advanced Agricultural Research & Technology Journal	2(2):198- 201, 2018
24	F. Sanudi, S. T. Indulkar, A. D. Adsul, A. S. Pawase and M. S. Sawant	Lethal Toxicity of Glyphosate Herbicide on Koi Carp, <i>Cyprinus carpio</i> (Linnaeus, 1758) Fingerlings	Toxicology International	25(2), 139- 141, 2018
25	VR Patil, A.S. Pawase , DI	Effect of exogenous carbohydrases on	International Journal of	7(1): 39-43,

	Pathan, RA Pawar, SS Dey and S Swain	growth and survival of catla fry	Fisheries and Aquatic Studies;	2019
26	Sachin L Kurkute, Anil S. Pawase, Sangeeta Dey, Dabir I Pathan, Milind S Sawant and Sagarika Swain	Effect of some minerals on shell hardening of mud crab, <i>Scylla serrata</i> (Forsk, 1775)	International Journal of Fisheries and Aquatic Studies	7(1): 44-47, 2019
27	P. P. Malgundkar, A. S. Pawase, R. M. Tibile, S. S. Dey, and A. T. Shelke	Effect of vitamin C on egg hatching and spawn survival of blue gourami, <i>Trichopodus</i> <i>trichopterus</i> (Pallas, 1770)	International Journal of Fisheries and Aquatic Studies	7(1): 72-74, 2019
28	Mudasir Maqsood Hakim, Milind Sawant, Ravindra Pawar, Shafat Hussain and Anil Pawase	Morphometry based identification of <i>Nemipterus japonicus</i> unit stocks from west coast of India	Journal of Entomology and Zoology Studies	7(1): 819- 826, 2019
29	S. Swain, A. S. Pawase, R. K. Pai, R. M. Tibile, S. T. Indulkar, R. A. Pawar and A. P. Acharya	Effect of immonostimulants on growth performance of striped catfish, <i>Pangasianodon</i> <i>hypophthalmus</i> (Sauvage, 1878)	J. Exp. Zool. India	22(2):917- 920, 2019
30	Sana K.M. Patel*, S. T. Indulkar, Abdul Lateef A. H. Shaikh, M.S. Sawant, A. S. Pawase and R. K. Pai	Effect of calcium carbide on biochemical properties of Rosy Barb, <i>Pethia conchonius</i> (Hamilton,1822)	J. Exp. Zool. India	22(2):995- 999, 2019
31	Priyanka Pradip Malgundkar, Anil Sawalaram Pawase, Sushree Sangeeta Dey, Raju Mahadev Tibile, and Amol Arvind Shelke	Effect of Dietary Vitamin C on Growth and Survival of Juveniles of Blue Gourami, <i>Trichopodus</i> <i>trichopterus</i> (Pallas, 1770)	Journal of Coastal Research	86: 96– 101,2019
32	Sawant, N.S.,	Maturation of different	Journal of	

	Pathan, D.I., Pawase, A.S. , Tibile, R.M. and Desai, P. S.	filter media using culture water	Entomology and Zoology Studies	8(1): 63-68, 2020
33	N.S. Sawant, D.I. Pathan, A.S. Pawase , R.M. Tibile and P. S. Desai	Effect of filter media on survival and growth of <i>Macrobrachium rosenbergii</i> larvae in artificial seawater recirculating system	BIOINFOLET	17 (1A): 18 23, 2020
34	Chetan Shankar Niwalkar, Sushree Sangeeta Dey*, Anil Sawalaram Pawase , Dabir I. Pathan, Hukam Singh Dhaker, Milind S. Sawant and Sagarika Swain	Optimization of feeding ration in the spawn rearing of striped catfish, <i>Pangasianodon hypophthalmus</i> (Sauvage, 1878)	J. Exp. Zool. India	23(1)747- 751,2020
35	Chetan Shankar Niwalkar, Anil Sawalaram Pawase , Dabir I. Pathan, Hukam Singh Dhaker, Milind S. Sawant and Sushree Sangeeta Dey*	Growth and survival of striped catfish, <i>Pangasianodon hypophthalmus</i> (Sauvage, 1878) spawn at different stocking densities	J. Exp. Zool. India	23(1)759- 763,2020
36	L.S. Uskelwar, M.S. Sawant, R.A. Pawar, V.H. Nirmale, A.S. Pawase and S.Y. Metar	Food and Feeding Biology of Brackish Water Fish <i>Epinephelus diacanthus</i> along the South Konkan Coast of Maharashtra, India	International Journal of Current Microbiology and Applied Sciences	7(12) 3106- 3110,2018
37	F. Sanudi, S.T. Indulkar, A.D. Adsul, A.S. Pawase , M.S. Sawant	Effects of Glyphosate Herbicide on Physiological Parameters of Koi Carp, <i>Cyprinus Carpio</i> (Linnaeus, 1758) Fingerlings	Indian Journal of Animal Research	B-3827:[1-5]
38	S. S. Wasave, B. R. Chavan, S. D.	Role of microbes in biofloc systems : a	J. Exp. Zool. India	23(1) 903- 906, 2020

	Naik, S. M. Wasave, A. S. Pawase, R. M. Tibile, G. S. Ghode, S. J. Meshram and V. S. Shivalkar	review		
39	Udai R. Gurjar, Suman Takar, Milind S. Sawant, Ravindra A. Pawar, Vivek H. Nirmale, Anil S. Pawase, Sushanta K. Chakraborty, Karan K. Ramteke and Tarachand Kumawat	Preliminary observation on the sustainability of white sardine, <i>Escualosa thoracata</i> (Valenciennes, 1847), exploited from the central west coast of India	The Journal of Basic and Applied Zoology	82:20, 2021

Papers published in proceedings of symposium/seminar

Sr. No.	Author/s	Title of the paper	Proceedings	Volume, page number, year
1	Pawase, A. S. and Shakuntala Shenoy	Salinity effect on growth of some important penaeid prawns of Ratnagiri	Current and emerging trends in aquaculture, P.C.Thomas (ed), Daya Publi. House, Delhi	30-34, 1998
2	Pawase, A. S. and Shakuntala Shenoy	Experimental farm trial on <i>Penaeus merguensis</i> in Ratnagiri (Konkan, Maharashtra),	Current and emerging trends in aquaculture, P.C.Thomas (ed), Daya Publi. House, Delhi :	74-79, 1998
3	Pawase, A. S. and Shakuntala Shenoy	Growth experiments on <i>Penaeus merguensis</i> and <i>Metapenaeus monoceros</i> from Ratnagiri using different pelleted feeds	Current and emerging trends in aquaculture, P.C.Thomas (ed), Daya Publi. House, Delhi	114-118, 1998
4	Sankolli, K N,	Low cost farming potential of prawn species	<i>Freshwater Prawns: Advances</i>	719-725, 2007

	Shakuntala Shenoy and A .S. Pawase	of minor <i>Macrobrachium</i> Bate, 1868 (family Palaemonidae) and <i>Caridina</i> H. Milne Edwards, 1837(family Atyidae) in India.	<i>in Biology, Aquaculture & Marketing. Proceedings of Freshwater Prawns 2003, International Symposium on Freshwater Prawns, 20-23 August 2003, Kochi, India</i> (ed. by C.M. Nair & D.D. Nambudiri), pp. 719 – 725. Allied Publishers, 5New Delhi, India.	
	Sabina I. Darve, S. T. Indulkar and A. S. Pawase	Evaluation of optimum salinity for rearing of Indian Medaka, <i>Oryzias melastigma</i> (McClelland, 1839)	<i>The Seventh Indian Fisheries Forum Proceedings.</i> Asian Fisheries Society, 2007. Manglore, India (ed. By C.Vasudevappa, Y.Basavaraju, D.Seenappa, S. Ayyappan and S. Ravichandra Reddy), AFSIB Manglore, ICAR, UAS(B), KVAFSU(B) & FFT(B), India.	451, 2007

4. Publications of Dr. B. R. Chavan

Sr. No.	Author/s	Title of the paper	Journal	Volume, Page number, year
Name of staff member: Raju M. Tibile				
1	R. P. Rathod, B. R. Chavan, N. S. Deshpande and R. Pai	Cage Culture: An Opportunity for Culture Based Capture Fisheries in Reservoirs of Konkan Region of Maharashtra	Fishing chimes,	Vol. 36 No. 10, PP. 44-47, 2017
2	B. R. Chavan, M. T. Kamble, V. B.	Capacity Building for Sustainable	Journal of Multidisciplinary /	Vol. 1 No. 6 pp. 11-19.

	Sutar and R. Pai	Aquaculture for Food Security and Rural Livelihood through Fisheries Education and Extension in India	Interdisciplinary Studies and Research,	2017
3	B. R. Chavan: H. Singh and R Pai	Entrepreneurship in Management of Natural Resources for Sustainability of Rural Youth of Maharashtra State	Social Entrepreneurship in Aquaculture, Narendra Publishing House, Delhi, India. <i>Edited by:</i> V.R.P. Sinha, Gopal Krishna, P. Keshavanath and Nalini Ranjan Kumar.	2016
4	Aulia Rahma, Manoj T. Kamble, Gabriel A. Ataguba, Balu R. Chavan, Rachmawati Rusydi and Siska Melisa	Steroidogenic and thermal control of sex in tilapia (<i>O. niloticus</i>): A review	International Journal of Current Microbiology and Applied Science ISSN: 2319-7706,	22(1), Volume 4 Number 1 (2015) pp. 214-229
5	Manoj T. Kamble, Wenresti G. Gallardo, Amaratne Yakupitiyage, Balu R. Chavan, Rachmawati Rusydi and Aulia Rahma	Antimicrobial Activity of Bioactive Herbal Extracts Against <i>Streptococcus agalactiae</i> Biotype-2	International Journal of Basis and Applied Biology Print ISSN: 2394-5820, Online ISSN: 2349-2539,	Vol 2, No 3; Oct-Dec, 2014 pp. 152-155
6	B R. Chavan, H. S. Dhaker and A. B. Funde	Community Based Adoption & Management of Cage Fish Culture in Underutilized Aquatic Impoundment for Food Security and Rural Livelihood	Journal of Science Information ISSN-2229-5836,	Vol. 9 Issue. 9, PP. 13-19, 2014
7	Lagade V. M., Chavan B. R., Taware S. S. and Muley D. V.	Sustainable Management And Conservation of Penaeid Shrimps In Mangrove Areas of Bhatye, Ratnagiri Coast	International Science Journal, ISSN: 2348 – 604X (Print); 2348 – 6058 (Online)	Vol- 1 Issue-1, PP. 81-86. 2014
8	Gabriel A.	Potency of Herbal	International	Vol 2, No.

	Ataguba, Manoj T. Kamble, Samuel Omeji, Txomin Azpeitia, Balu R. Chavan and Seema V. Medhe	Extracts for the Treatment of Streptococcus Infection in Tilapia.	Journal of Basis and Applied Biology,	3; Oct-Dec, 2014 pp. 137-142. 2014
9	Sutar V. B., Chavan B. R., Bonde V. R. and Balamani C. H	Efficacy of Farm Yard Manure And Vermi compost on Growth And Survival of <i>Catla Catla</i> , <i>Labeo Rohita</i> and <i>M. Rosenbergi</i> In Rearing Pond	DAV International Journal of Science,	Vol. 1 Issue:2, pp 128-131. 2012
10	B. R. Chavan, A. Yakupitiyage, and S. Kumar	Drying Performance, Quality Characteristics and Financial Evaluation of Indian Mackerel (<i>Rastrilliger Kangurta</i>) Dried By Solar Tunnel Dryer	Thammasat International Journal for Science and Technology	Vol. 16, No. 2, April-June 2011: PP.11-25
11	B. R. Chavan, S. R. Kovale and A. Yakupitiyage	Evaluation of nutritional value of natural feed and pelleted feeds of Nile Tilapia. (<i>Oreochromis niloticus</i>) culture.	Ecology and Fisheries,	Vo. 2, No. 2, Dec, 2009. PP. 53-62.
12	B. R. Chavan, A. Yakupitiyage, and S. Kumar	Socio-Economic Analysis of Small-Scale Fisher Toward Coastal Fishery Management For Rural Development In Maharashtra Coast, India.	Asia-Pacific Journal of Rural Development,	Vol. XIX, No. 2, Dec, 2009. PP. 31-45.
13	B. R. Chavan, S. Basu and S. R. Kovale	Development of Edible Texturised Dried Fish Granules from Low-Value Fish Croaker (<i>Otolithus argenteus</i>) & its Characteristics	CMU International Journal on Natural Science,	Vol. 7, No. 1, Jan-June, 2008. PP. 173-182.
14	B.R. Chavan, M.P. Bhilave, M.T.Wakade, Pallavi Shinde	Influence of Sugar Concentration in the Food Source on the Foraging Behavior of <i>Apis mellifera</i> ,	ENTOMON ISSN: 0377-9335 (IF 0.2),	34(1): 51-52. 2008
15	V. P. Joshi, B. R. Chavan, S. T. Sharangdher, J.	Fish drying: Development of solar panel Dryer	Fishing chimes	Vol. 24 No. 6, PP. 34-35. 2004

	M. Koli, Patonkar and V. R. Joshi			
16	Satam S. B., Sadavarte V. R., Sawant A. N., Chogale N. D., Metar S. Y. and Chavan B. R.	Ornamental Fish Biodiversity in Mirya Creek of Ratnagiri	Ecology and Fisheries,	Vo. 8, No.1, Jan, 2015. PP. 32-36
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19	H. B. Dhamgaye*, S. P. Jadhao, S. J. Meshram, B. R. Chavan, R. K. Sadawarte	Effect of Fipronil on oxygen consumption and Ammonia excretion of Mahseer (<i>Tor khudree</i>) fry.	Indian J. Anim. Hlth. (2020), ISSN 0019-5057.	59(1): 91- 96. pp. 91 – 96 2020
20	K. S. Sawant*, S. J. Meshram, H. B. Dhamagaye, B. R. Chavan, R. M. Tibile and V. R. Vartak	Growth performance of GIFT tilapia (<i>Oreochromis niloticus</i>) fry in Biofloc system using different carbon sources.	Journal of Experimental Zoology, India. ISSN 0972-0030. 2020	Vol. 23, Supplement 1, pp. 765- 769, 2020
21	Wasave SS, Chavan BR*, Pawase AS, Shirdhankar MM, Mohite AS,	Application of agro- wastes to enhance freshwater fish Production of	International Journal of Fisheries and Aquatic Studies 2020ISSN: 2394-	8(4): 206- 211. P- 2020

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22	S. N. Kamble, H. B. Dhamagaye*, S. J. Meshram, B. R. Chavan and G. N. Kulkarni	Toxic effect of Fungicide Paclobutrazol on Immunological Parameters of Juveniles Whiteleg Shrimp, <i>Litopenaeus vannamei</i>	Journal of Experimental Zoology, India. ISSN 0972-0030. 2020.	Vol. 23, Supplement 1, pp. 895-901, 2020.
23	Somnath R. Yadav ¹ and B. R. Chavan*	Performance evaluation of sensors for use in aquaculture.	Journal of Experimental Zoology, India. ISSN 0972-0030.	Vol. 23, No.2, pp. 1007-1018, 2020.
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25	B. R. Chavan*, A. Yakupitiyage S. Kumar and V.B. Sutar	Biochemical, Microbial and Sensory Properties of Mackerel (<i>Rastrilliger kangurta</i>) Dried in Solar-Biomass Hybrid Tunnel Dryer	Asian Journal of Microbiology, Biotechnology and Environmental Science, ISSN-0972-3005	Vol. 18, No. (1) : 171-179:, 2016
26	B. R. Chavan* R. Pai, H. Singh and U. V. Mahadkar	Rearing of Fish Fingerling in Cages in Reservoir for Food Security and Rural Livelihood	International Journal of Tropical Agriculture. ISSN: 0254-8755	Vol. 34, No. 4: 903-907, 2016
27	M.B. Nikam*, S.S. Burark, A.C. Deorukhkar, B.R. Chavan and R.P. Mhadik	Integrated Farming Systems for Sustainable Agriculture in Raigad District of Maharashtra..	International Journal of Agriculture, Environment and Biotechnology, Citation: IJAEB: ISSN : 0974-1712	13(2): 01-08, June 2020.
28	S. S. Wasave*, B. R. Chavan, S. D. Naik, S. M. Wasave, A. S.	Role of Microbes In Biofloc Systems : A Review	<i>J. Exp. Zool. India</i> ISSN 0972-0030	Vol. 23, Supplement 1, pp. 903-

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31	N. D. Chogale* , B. R. Chavan, V. R. Sadawarte, R. Pai, A. U. Pagarkar, S. Y. Metar, S. B. Satam, K. M. Shinde, A. N. Sawant and H Singh	Production of <i>Chaetoceros calcitrans</i> in different nutritive condition in shrimp hatchery, wadamirya, Ratnagiri.	Contemporary Research in India. Multidisciplinary International Journal. ISSN: 2231-2137.	pp.52-56; 2018
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33	Manoj T. Kamble, Vijay B. Sutar and Balasaheb R. Chavan*	Application of agro- wastes to enhance freshwater fish Production of Maharashtra.	Contemporary Research in India. Multidisciplinary International Journal. ISSN: 2231-2137.	pp.38-42; 2018

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37	B. P. Boye, B. R. Chavan*, V. R. Sadawarte, A. N. Sawant	Effect of different stocking densities on Growth performance of <i>Catla catla</i> fry reared in Harvested Rain water in cement tank.	International Journal of Tropical Agriculture. ISSN: 0254-8755	36, 4: 837-842. 2018
38	Manoj Tukaram Kamble*, Amaratne Yakupitiyage, Krishna Rugmini Salin, Balasaheb Ramdas Chavan	Effect of <i>Psidium guajava</i> and <i>Phyllanthus acidus</i> Leaf Extract on Immunostimulant Response of Nile Tilapia Against <i>Streptococcus agalactiae</i> Infection	The Israeli Journal of Aquaculture, Bamidgheh, ISSN: 0792-156X, 2018	ISSN: 0792-156X, 2018
39	Shashikant J. Meshram, Shivananda Murthy, Harish B. Dhamgaye*, B. R. Chavan, H. S. Swain, M. J. Gitte and A. Ali	Effect of dietary beta-glucan on the hepatopancreas of giant freshwater prawn, <i>Macrobrachium rosenbergii</i> .	Contemporary Research in India. Multidisciplinary International Journal. ISSN: 2231-2137.	pp. 88-91; 2018
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41	B. P. BHOYE1, B. R. CHAVAN1*, V. R. SADAVARTE1, H. B. DHAMAGAYE1 , M. T. Kamble2 and B. T. SAWANT1	Rearing of Freshwater Fish 'Catla catla (Hamilton, 1822)' Spawn to Fry in Green Water System with Harvested Rain Water in Cement Tanks	Current Agriculture Research Journal. ISSN: 2347-4688.	2017; 5 (1).
42	R. P. Rathod, B. R. Chavan* and R. K. Pai	Zooplankton Diversity Indices and Seasonal Variations in Kadwai Reservoir, Ratnagiri District, Maharashtra, India	International Journal of Tropical Agriculture. ISSN: 0254-8755	Vol. 34, No. 3: 785-790. 2016
43	R. P. Rathod, B. R. Chavan* and R. K. Pai	Variation in Primary Production In Relation to Physico-chemical parameters of Kadwai Reservoir, Ratnagiri, Maharashtra, India.	Current World Environment An International Research Journal of Environmental Science, ISSN: 0973-4929.	2016; 11 (1),
44	B. R. Chavan*, A. Yakupitiyage, S. Kumar and V. B. Sutar	Effect of Drying in Solar-Biomass Hybrid Tunnel Dryer On Biochemical, Microbial and Sensory Properties of Mackerel (<i>Rastrilliger Kangurta</i>)	International journal of food and fermentation Technology, Print ISSN No 2249-1570.	5 (2): 201-211,
45	B. R. Chavan*, R. Pai and H. Singh	Establishment of fish fingerlings by using fish cages for stock enhancement of underutilized aquatic impoundments.	Bhartiya Krishi Anusandhan Patrika.	29 (4): 201-204 2015

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47	B. R. Chavan *, Yakupitiyage A., V. B. Sutar.	Mathematical Modeling And Quality Characteristics of Indian Mackerel (<i>Rastrilliger Kangurta</i>) Dried In Solar Cabinet Dryer	Bioinfolet, ISSN- 0973-1431	12 (4 A):838-845. 2015
48	Gabriel A. Ataguba *, Manoj T. Kamble, Gabriel R. Okayi and B. R. Chavan	An overview and assessment of two wetlands in Eastern Thailand: Kung krabaen bay and welu wetlands in chanthaburi province	International Journal of Agriculture, Environment and Biotechnology.	8(1): 205- 213 2015
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50	Balu Ramdas Chavan*	Improvement of Quality Characteristics of Indian Mackerel (<i>Rastrilliger kanagurta</i>) by Solar Drying	Drying Technology,	27: 823- 824, 2009
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Sr. No.	Author/s	Title of the paper	Proceeding	Volume, Page number, year
1.	M P Bhilave B R Chavan	Impact of Heavy Metals on Freshwater fish <i>Cirrhinus mrigala</i> in relation to Oxygen consumption.	International Agricultural Engineering Conference; Bangkok, Thailand, ISBN 9789748257488,3-6 December,2007: 47.	2007

5. Publications of Dr. S. J. Meshram

Sr. No.	Author/s	Title of the paper	Journal	Volume, Page number, year
Name of staff member: Dr. Shashikant J. Meshram				
1	Meshram S.J. ,Sawardekar, S.V., Dhane, S.S. and Mahale, D.M	Feasibility of rice – cum – fish culture in coastal saline land of Maharashtra	J. Indian Soc. of Coastal, agric. Res	21 (1), 75-78, 2003
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3	Shingare, P.E. Meshram, S.J. , Dhane, S.S.,	Observations on fishery of windowpane oyster in north Konkan coast of Maharashtra	J. Ind. Soc., of coastal Agril Res.,	Vol.22 No. 1and 2, pp 306 – 307, 2004
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6	P. E. Shingare, S. J. Meshram , R. K. Singh, J. H. Dongale, S. S. Dhane	Studies on effect of <i>Lactobacillus acidophilus</i> , a feed probiotic on growth of seed of <i>Labeo rohita</i>	J. Indian Soc. Coastal Agri.Res	. 24(2), 264-266, 2006

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10	Himanshu S. Swain, Ratnamanjiri Senapati, S. J. Meshram , R. Mishra and Shivananda Murthy H.	Effect of dietary supplementation of marigold oleoresin on growth, survival and total muscle Carotenoids of Koi carp <i>Cyprinus carpio</i>	Int. J. of Applied and Natural Science	Vol. 6 No. 2, pp 430-435, 2014
11	S. J. Meshram , Shivananda Murthy H, Ali H., Swain H. S., Abhiman Ballyaya	Effect of dietary beta- glucan on immune response and disease resistance against <i>Aeromonas hydrophila</i> in giant freshwater prawn, <i>Macrobrachium</i> <i>rosenbergii</i> (de Man, 1879)	Aquaculture International	23: 439-447, 2015
12	Harish B. Dhamagaye, Gangadhara Gowda, C. Shruthisree, Harsha Nayak Shashikant J. Meshram	Oxygen Consumption and Ammonia Excretion of Iridescent Shark, <i>Pangasius hypophthalmus</i> Exposed to Cypermethrin	J. Exp. Zool. India	Vol.18 No. 1, pp 381-385., 2015
13	A. Hosseinpoor Zelaty, H. Shivanada Murthy, Nilima Priyadarshini, S. J. Meshram and Adnan Amin	Effect of dietary marigold oleresin on growth performance, survival, body composition and water quality changes during <i>Macrobrachium</i> <i>rosenbergii</i> culture	J. Exp. Zool. India	Vol. 19, No. 2, pp. 785-791, 2016

14	R. K. Sadawarte, V. R. Sadawarte, V.B. Mulye, S.J. Meshram and H. B. Dhamagaye	Effect of ethinyl-estradiol on growth of fry of rosy barb, <i>Puntius conchoni</i>	Eco. Env. & Cons.	22 (June Suppl.) : pp. (S201-S203), 2016
15	R.K. Sadawarte, V.R. Sadawarte, V.B. Mulye, S.J. Meshram and H.B. Dhamgaye	Effect of 17 α -Methyltestosterone on growth of fry of rosy barb, <i>Puntius conchoni</i>	Eco. Env. & Cons	22 (June Suppl.) : pp. (S201-S203), 2016
16	S. J. Meshram , Shivananda Murthy H, H., Swain H. S., Pai R. A. Ali and H. B. Dhamgaye	Preliminary Study of the Effect of Dietary Beta-Glucan on the Gut Morphology of Giant Freshwater Prawn, <i>Macrobrachium Rosenbergii</i>	Journal of Aquaculture & Marine Biology	Volume 4 Issue 4 - 2016
17	Adnan Amin and Swain HS Hosseinpoor Zelaty, Shivananda Murthy, Majid Nazarkardeh, Seyyedeh Hoda Ahmadiyan, Meshram SJ	Influence of dietary supplementation of carotenoid (Diacetate of Lutein-Mesozeaxanthin) on growth performance, biochemical body composition in freshwater prawn, <i>Macrobrachium rosenbrgi i</i>	Journal of Aquaculture & Marine Biology	Volume 4 Issue 2 , page 1-8, 2016
18	M. N. Ghane, H.B. Dhamagaye, S. J. Meshram and A. D. Salunke	Toxicity Effect of Paclobutrazol Fungicide on Haematological Parameters in <i>Oreochromis mossambicus</i> Fingerlings	Trends in Biosciences	210 (33) pp 7146-7155, 2017
19	Sonali Thool, B. R. Chavan and S. J. Meshram	Present status, Prospectus of Freshwater fish production and future need of Wardha District of Maharashtra.	Contemporary Research in India journal	Special Issue National Conference (ERCA-2018) pp 156-158, 2018
20	Shashikant J. Meshram , Shivananda Murthy, Harish B. Dhamgaye, B. R. Chavan, H. S. Swain, M. J. Gitte and A. Ali	Effect of dietary beta-glucan on the hepatopancreas of giant freshwater prawn, <i>Macrobrachium rosenbergii</i> .	Contemporary Research in India journal	Special Issue National Conference (ERCA-2018) pp 87-90, 2018
21	H. B. Dhamagaye, A. M. Ranade, S. J. Meshram , S. D.	Proximate composition and growth study of green mussel <i>Perna viridis</i> (L.) from Mirya creek in	Contemporary Research in India journal	Special Issue National Conference (ERCA-2018) pp

	Naik, R. K. Sadavarte M. J. Gitte and Sachin Belasare	Ratnagiri, Maharashtra, India		80-86, 2018
22	Bhosle R. V., Chavan B. R., Meshram S. J. , Dhamagaye H. B., Wasave S. S. and Pai R	Growth performance of gift tilapia (<i>Oreochromis niloticus</i>) fry in nursery rearing by using Brackish water	Contemporary Research in India journal	Special Issue National Conference (ERCA-2018) pp 31-35, 2018
23	S. T. Khade, P. C. Lokhande*, M. T. Sharangdhar, A. D. Kolekar, S. J. Meshram , M. J. Gitte, S. T. Sharangdhar, V. V. Bansode and H. S. Dhaker	Effect of different protein levels and stocking densities on growth and survival of juveniles of oscar, <i>Astronotus ocellatus</i>	J. Exp. Zool. India	Vol. 21, No. 2, pp. 641-647, 2018
24	M.N. Ghane, H.B. Dhamagaye, S.J. Meshram and A.D. Salunke	Toxic Effect of Paclobutrazol Fungicide in <i>Oreochromis mossambicus</i> Fingerlings	Pesticide Research Journal.	30(1): 112-116, 2018
25	Pawase, A.S., Ghode, G.S., Tibile, R.M., Pathan, D.I., Sawant, K.S., Chavan, B.R., Meshram, S.J. , Bhatkar, V.R., Patil, V.K., Rane, A.D., Haldankar, P.M., Bhattacharyya, T.	Boosting fishermen's income by brackish water shrimp culture	Advanced Agricultural Research and Technology Journal,	2(2): 198-201, 2018 (July)
26	A. B. Ranadive, S. J. Meshram , RM Tibile, RK Pai, SK Hundare	Growth and Immune Gene Expression by Dietary Supplementation of Mannan Oligosaccharide in Fry of Deccan Mahseer, <i>Tor khudree</i>	International Journal of Bio- resource and Stress Management	9(6):707-712, 2018
27	K. S. Sawant, S. J. Meshram , H. B. Dhamagaye, B. R. Chavan, R. M. Tibile and V. R. Vartak	Growth and survival of <i>Labeo rohita</i> (hamilton, 1822) fry in biofloc system using various dietary protein levels	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 765-769, 2020
28	S. N. Kamble, H. B. Dhamagaye, S. J. Meshram , B. R.	Toxic effect of fungicide paclobutrazol on immunological	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 895-901 2020

	Chavan and G. N. Kulkarni	parameters of juveniles whiteleg shrimp, <i>Litopenaeus vannamei</i>		
29	S. J. Meshram, H. B. Dhamagaye, H. S. Swain, H. S. Murthy, A. Ali, M. J. Gitte and R. K. Sadawarte	Effect of dietary supplementation of mannan oligosaccharide on growth and survival of giant freshwater prawn, <i>Macrobrachium rosenbergii</i>	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 895-901 2020
30	J. K. Hire, S. S. Wasave, R. Pai, S. J. Meshram, G. S. Ghode, S. S. Sawant and S. M. Wasave	Effect of probiotic, bacillus spp. enriched artemia on growth of gold fish, <i>Carassius auratus</i> (linnaeus, 1758) larvae	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 741-745, 2020
31	RP Mahadik, SJ Meshram, SC Warwadekar, MH Khanvilkar, MJ Gitte	Knowledge level of trainees towards freshwater fish cultivation training programmes	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 879-881, 2020
32	H. B. Dhamgaye, S. P. Jadhao, S. J. Meshram, B. R. Chavan and R. K. Sadawarte	Effect of fipronil on oxygen consumption and ammonia excretion of mahseer (<i>Tor khudree</i>) fry	Indian J. Anim. Hlth.	59(1) : 91-96, 2020
33	S. S. Wasave, B. R. Chavan, S. D. Naik, S. M. Wasave, A. S. Pawase, R. M. Tibile, G. S. Ghode, S. J. Meshram and V. S. Shivalkar	Role of microbes in biofloc systems : a review	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 903-906, 2020
34	P. E. Shingare, A. U. Pagarkar, K. J. Chaudhari, H. S. Dhaker, S. J. Meshram, N. H. Sawant, S. B. Satam, S. P. Shingare, B. T. Sawant, P. H. Sapkale, R. D. Bondre, S. D. Patil, S. V. Sawardekar and	Eco-friendly and sustainable asian seabass culture system : an alternate candidate species other than shrimp for brackishwater aquaculture	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 983-985, 2020

	A. N. Narangalkar			
35	M J Gitte, S J Meshram , B T Sawant, S V Patil, B V Naik, H B Dhamgaye and J S Arekar	Study on Aqua-entrepreneurship in <i>Litopenaeus vannamei</i> Culture in Raigad district of Maharashtra	J Krishi Vigyan	9 (2) : 221-224, 2020
36	Harish B. Dhamagaye, Gangadhara Gowda, SruthiSree C., Harsha Nayak, Shashikant J. Meshram , Balasaheb R. Chavan ³ , and R. K. Sadavarte	Haematological and Histological changes in the Iridescent Shark, <i>Pangasius hypophthalmus</i> (Sauvage, 1878) exposed to Sub-lethal Concentrations of Cypermethrin	Pesticide Research Journal .	33(2) : 35-42
37	Nirmale V.H. , Metar S.Y. , Chogale N.D. , Pawar R.A. , Sawant B.T. , Gitte M.J. , Meshram S.J. , Sadawarte R.K. , Bondre R.B. , Yadav B.M.	Growth and mortality of Kiddy Shrimp, <i>Parapenaeopsis stylifera</i> (H.Milne Edwards, 1837) along the coast of Maharashtra	Regional Studies in Marine Science	48 (2021) 102030
38	Sonia*, S. J. Meshram , S. D. Naik, P. E. Shingare, H. B. Dhamagaye, B. M. Yadav and Sonam Tijare <i>ISSN 0972-0030</i>	Evaluation of different stocking densities and carbon:nitrogen ratios on growth, body composition and production performance of <i>Labeo rohita</i> (Hamilton, 1822) spawn in biofloc based-nursery system	Aquaculture Research	https://doi.org/10.1111/are.15985
39	S. K. Tijare*, S. J. Meshram , H. B. Dhamgaye, B. R. Chavan, S. S Wasave, Sonia Solanki, S. S. Upaskar and Y. V.	Hematological responses in catla, <i>Gibelion catla</i> against <i>aeromonas hydrophila</i> fed with different dietary protein in biofloc system	<i>J. Exp. Zool. India</i>	Vol. 26, No. 1, pp. 949-956, 2023

	Charthad			
40	S. K. Tijare*, S. J. Meshram, H. B. Dhamgaye, B. R. Chavan, S. S. Wasave, Sonia Solanki, S. S. Upaskar and Y. V. Charthad	Preliminary observations on gut histology of blue gourami, <i>Trichopodus trichopterus</i> (Pallas, 1770) youngones incorporated with sodium butyrate	<i>J. Exp. Zool. India</i>	Vol. 26, No. 1, pp. 213-217, 2023
41	Sonia Solanki,*, S. J. Meshram, H. B. Dhamagaye S. D. Naik, P.E. Shingare and B. M. Yadav	Effect of varying protein diets on liver and intestine histology of catla, <i>Gibelion catla</i> reared in indoor biofloc system	Journal of the Kalash Science	Volume-10, Number-1, 2022 : 15-22 ISSN: 2321-7634
42	Sonia Solanki,*, S. J. Meshram, H. B. Dhamagaye S. D. Naik, P.E. Shingare and B. M. Yadav	Effect of C/N Ratio Levels and Stocking Density of Catla Spawn (<i>Gibelion catla</i>) on Water Quality, Growth Performance, and Biofloc Nutritional Composition in an Indoor Biofloc System	Aquaculture Research	Volume 2023, Article ID 2501653, 11 pages

5. Publications of Dr. G. S. Ghode

Sr. No	Author/s	Title of the paper	Journal	Volume, Page number, year
1.	H.Singh, Sawant, D.V., Ghode, G.S., Mesharam, S.J. Bhalekar, M. S.	Seed Production of <i>M. rosenbergii</i> using artificial sea water.	Fishing Chimes	Vol. 31, No. 10, pp. (44-46) 2012
2	Pankaj. A. Patil, Raju. M. Tibile, Anil. S. Pawase and Gajanan. Ghode	Growth and Survival of Angelfish, <i>Pterophyllum scalare</i> (Schultze, 1823) fry reared at different stocking densities	J. Env. Bio.Sci	Vol. 29 (1):pp. (167-172) 2015
3	Sachin Onkar Khairnar, H. Singh, B. V. Solank, P. U. Kapse, P. E. Shingare, G. S. Ghode	Effect of various feeding rations on growth, survival and body composition of gold spot mullet (<i>Liza parsia</i>) fry reared in cages.	Journal of Animal Feed Science and Technology	Vol.3 pp.(19-23) 2015

4	Hemchandra, N., Dhaker, H. S., Pathan, D. I. and Ghode, G.	Effect of sediment depth, calcium hardness of water and feeding ration on nacre formation in freshwater mussel <i>Lamellidens corrianus</i> (Lea, 1834)	Indian Journal of Fisheries	Vol. 62(2): pp. (43-48), 2015
5	S.V. Jadhav, G.S. Ghode, D.I. Pathan, H.S. Dhaker, P. K. Pandey and H.D. Joshi, 2015	Evaluation of some anesthetics for use in husbandry and transportation of angelfish, <i>Pterophyllum scalare</i> (Schultze, 1823)	<i>Eco. Env. & Cons.</i>	Vol.21., Issue, pp. (487-496) 2015
6	Joshi,H.D., Ghode, G.S., Gore, S.B.	Efficiency of letrozole loaded PLGA nanoparticles on sex reversal of <i>Poecilia reticulata</i> (Peters, 1859)	Journal of Applied and Natural Science	Vol.7 (1) : pp.(394 – 399) 2015
7	P. A. Patil, R. M. Tibile ² , G. S. Ghode ² and A. S. Pawase ²	GROWTH PERFORMANCE OF ANGELFISH, <i>PTEROPHYLLUM SCALARE</i> (SCHULTZE, 1823) FRY REARED AT DIFFERENT STOCKING DENSITIES WITH UNDER-GRAVEL FILTRATION SYSTEM	J. Exp. Zool. India	Vol. 20, No. 2, pp. (1001-1007) 2017
8	Ghode, G., Rathore, G., Paniprasad, K., Kumar, K., and Pai, R.	Detection and tissue profiling of TLR4 and MyD88 in <i>Pangasianodon hypophthalmus</i> using PCR	J. Exp. Zool. India	Vol. 21(1); pp. (191-196) 2018
9	Pawase ¹ , A.S., Ghode ¹ , G.S., Tibile ¹ , R.M., Pathan ¹ , D.I., Sawant ¹ , K.S., Chavani ¹ ,B. R., Meshram ¹ , S.J., Bhatkar ¹ , V.R., Patil ² , V.K., Rane ² , A.D., Haldankar ^{P.M.} , Bhattacharyya, T.	Boosting Fishermen's Income by Brackishwater Shrimp Culture	Advanced Agricultural Research & Technology Journal	Vol. II ,(2);pp. 2018
10	Wasave, S. S., Chavan, B. R., Naik, S. D., Wasave, S. M. , Pawase, A. S., Tibile, R. M., Ghode, G. S., Meshram S. J., Shivalkar, V. S.	Role of microbes in bioflock system: A review	J. Exp. Zool. India	Vol. 23, Supplement 1, pp. 903-906, 2020
11	Hire, J. K., Wasave, S.	Effect of probiotic bacillus	J. Exp. Zool. India	Vol. 23,

	S., Pai, R., Meshram, S. J., Ghode, G. S., Sawant, S. S., Wasave, S. M.	spp. enriched artemia on growth of goldfish, <i>Carassius auratus</i> (Linnaeus, 1758) larvae		Supplement 1, pp. 741-745, 2020
12	Rathod, A.G., Pathan, D.I., Shirdhankar, M.M., Pai, R., Sawant, M.S., Ghode, G.S.	Field cultivation of <i>Kappaphycus alvarezii</i> (Doty) Doty Ex <i>P. silva</i> with different stocking densities at Mirya Bandar, Ratnagiri, Maharashtra	J. Exp. Zool. India	Vol. 23, No. 2, pp. 1311-1315, 2020
13	Rathod, A.G., Pathan, D.I., Shirdhankar, M.M., Pai, R., Sawant, M.S., Ghode, G.S. and Tibile R.M.	Growth performance studies of <i>kappahycus alvarezii</i> (doty) using different spacing intervals on raft culture method	J. Exp. Zool. India	Vol. 25, No. 1, pp. 1249-1253, 2022
14	Rathinam, B. R., Banu, H., Ghode, G.S., Shashi Bhushan, Bhuvanewari, R., and Tripathi, G.	High prevalence of aeromonas and pseudomonas infections among cage cultured pangas catfish from the reservoirs of maharashtra, india	The Israeli Journal of Aquaculture	IJA.73.2021.1 531522
15	Kute, A.S., Tibile, R.M., Pawase, A.S., Ghode, G.S., Ghuguskar, M.M., Sawant, K.S., Waghmode, R.P., and Dey, S.S.	Growth and survival of rohu, <i>labeo rohita</i> (hamilton, 1822) fry using different carbon sources in biofloc system	J. Exp. Zool. India	Vol. 25, No. 2, pp. 1503-1510, 2022
16	Tibile, R.M., Ghode, G.S. and Pawar, R.A.	Pre- and post-spawning condition descriptors for the indian major carp, <i>cirrhinus mrigala</i>	Indian Journal of Animal Sciences	92 (11): 1368-1371, November 2022
17	Ghode, G., Rathore, G., Tripathi, G., Kashmira Davane, K., and Pani Prasad, K.	Molecular cloning, characterization and constitutive expression analysis of <i>tlr4</i> gene in pangasianodon hypophthalmus	Indian Journal of Animal Sciences	92 (10): 1245-1250, October 2022

vii) Full length research papers published in Proceedings of Seminar/Symposia /Conference/Workshop

Sr. No.	Author/s	Title of the paper	Proceeding	Volume, Page number, year
Name of staff member:				
1.	Indulkar, S.T., Tibile, R.M., Ghode, G.S.	Observations on introduction of giant freshwater prawn, <i>Macrobrachium rosenbergii</i> in small	The Seventh Indian Fisheries Proceedings, 322-325.	2005

		irrigation tanks of Konkan region of Maharashtra, India		
2.	Indulkar, S.T., Tibile, R.M., Ghode, G.S.	Effect of varying dietary mineral levels on growth, survival and feed utilization on post-larvae of <i>Macrobrachium rosenbergii</i> during indoor nursery rearing	The Seventh Indian Fisheries Proceedings, 326-330.	2005

6. Publications of Dr. R. M. Tibile

Sr. No.	Author/s	Title of the paper	Journal	Volume, Page number, year
Name of staff member: Raju M. Tibile				
1	Tibile, R.M., Singh, H.	Effect of various nutrient media on growth and cellular densities of marine microalga, <i>Isochrysis</i> spp.	Indian Journal Applied & Pure Biology	14(2), 90-97, 1999
2	Tibile, R.M., Singh, H.	Effects of some diets and salinity on maturation of edible oyster, <i>Crassostrea gryphoides</i> (Schlotheim).	Geobios	29, 229-232, 2002
3	Tibile, R.M., Singh, H.	Larval rearing and spat production of edible oyster <i>Crassostrea gryphoides</i> (Schlotheim).	Aquaculture Research	34, 785-792, 2003
4	Barve, S.K., Jalihal, D.R., Shirdhankar, M.M., Sawant, N.H., Tibile, R.M.	Sex ratio, gonadosomatic index and size progression of ova of mullet, <i>Liza parsia</i> off Ratnagiri, Maharashtra	Indian Journal Applied & Pure Biology	22(1), 1-6, 2003
5	Belsare, S.W., Singh, H., Yadav, B. M., Tibile, R.M.	Larval rearing of freshwater prawn <i>Machrobrachium rosenbergii</i> (De Man) in different formulations of artificial sea water.	Indian Journal Applied & Pure Biology	22(1), 1-6, 2007
6	Sanaye S.V., Tibile, R.M., Singh, H.	Neon tetra, <i>Paracheirodon innesi</i> : Breeding and seed production.	Fishing Chimes	27 (12), 48-49, 2008
7	Jakate, G.M., Singh, H.,	Effect of different substrata on growth and	Asian Fisheries Science	92(2), 561-567, 2009

	Ranade, A.M., Sawant, N.H., Pathan, D.I., Deolalikar, A.V., Tibile, R.M.	survival of green mussel <i>Perna viridis</i> on raft culture at Ratnagiri.		
8	Jamsandekar, S.S., Dhaker, H.S., Patil, S.V., Tibile, R.M., Patil, H.G.	Role of submerged macrophytes on water quality in an aquarium system.	Geobios	37(4), 327- 332, 2010
9	Sanaye, S.V., Singh, H., Tibile, R.M.	Growth and survival of neon tetra, <i>Paracheirodon innesi</i> (Myers, 1936) fry fed mixed zooplankton, formulated feed and combination thereof.	Annals of Biological Research,	3(12), 5665- 5668, 2012
10	Jadhav, S.P., Singh, H., Pathan, D.I., Tibile, R.M.	Effect of different levels of supplemental L- ascorbic acid in practical diet of <i>Tor khudree</i> (Sykes) fry	J. Indian Fish. Assoc.,	40, 23-36, 2013
11	Patil, P.A., Tibile, R.M., Pawase, A.S., Ghode, G.S.	Growth and survival of angelfish, <i>Pterophyllum</i> <i>scalare</i> (Schultze, 1823) fry reared at different stocking densities.	J. Env. Bio-Sci.,	29 (1), 167- 172, 2015
12	Tibile, R.M., Banerjee Sawant, P., Chadha, N.K., Lakra, W.S., Prakash, C., Swain, S., Bhagawati, K.	Effect of stocking density on growth, size variation, condition index and survival of discus, <i>Symphysodon</i> <i>aequifasciatus</i> Pellegrin,1904.	Turkish Journal of Fisheries and Aquatic Sciences,	16: 453-460, 2016
13	Bhatkar, H.R., Yadav, B.M., Shirdhankar, M.M., Gangan, S.S., Balange, A.K., Tibile, R.M.,	Studies on market structure and constraints of ornamental fish enterprise in Ratnagiri district of Maharashtra state	Journal of Indian Fisheries Association,	44(7): 55-61, 2016
14	Patil, P.A., Tibile, R.M., Ghode, G.S., Pawase, A.S.	Growth performance of angelfish, <i>Pterophyllum</i> <i>scalare</i> (Schultze, 1823) fry reared at different stocking densities with under-gravel filtration system.	Journal of Experimental Zoology of India,	20 (2): 1001- 1007, 2017
15	Pawase, A.S., Ghode, G.S.,	Boosting fishermen's income by brackishwater	Advanced Agricultural Research and	2(2): 198-201, 2018 (July)

	Tibile, R.M., Pathan, D.I., Sawant, K.S., Chavan, B.R., Meshram, S.J., Bhatkar, V.R., Patil, V.K., Rane, A.D., Haldankar, P.M., Bhattacharyya, T.	shrimp culture	Technology Journal,	
16	Hundare, S.K., Pathan, D.I., Pawase, A.S., Pai, R.K., Tibile, R.M. and Ranadive, A.B.	Use of fermented <i>Azolla</i> as fishmeal substitute in the tilapia fry diet	Contemporary Research in India	61-66, 2018 (Feb)
17	Jain, A.R., Pawar, R.A., Shirdhankar, M.M., Tibile, R.M. , Nirmale, V.H. and Raman, M.	Ujjani reservoir: An exemplary case of women empowerment in fisheries	Contemporary Research in India	118-120, 2018 (Feb)
18	Swain, S., Pawase, A.S., Pai, R.K., Tibile, R.M. , Indulkar, S.T., Pawar, R.A.	Effect of ginger (<i>Zingiber officinale</i> <i>Roscoe</i>) incorporated diet on growth performance of striped catfish, <i>Pangasianodon</i> <i>hypophthalmus</i> (Sauvage, 1878)	Journal of Entomology and Zoology Studies,	6(4): 1094- 1098, 2018
19	Swain, S., Banerjee Sawant, P., Chadha, N.K., Sundaray, J.K., Chandra Prakash, Tibile, R.M.	Effect of varying water pH on hormonal and haematological parameters of discus (<i>Symphysodon</i> <i>aequifasciatus</i>)	Journal of Experimental Zoology of India,	22 (1): 401- 406, 2019
20	Malgundkar, P. P., Pawase, A.S., Dey, S.S., Tibile, R.M. , Shelke, A.A.	Effect of dietary vitamin C on growth and survival of juveniles of blue gourami, <i>Trichopodus</i> <i>trichopterus</i> (Pallas, 1770)	Journal of Coastal Research,	86: 96-101, 2019
21	Naik, B.V., Patil, S.V., Shirdhankar, M.M., Yadav, B.M., Tibile, R.M. , Chaudhari, K.J., Wasave, S.M., Yewale,	Socio-economic profile of shrimp farmers of South-Konkan region, Maharashtra, India	Int. J. Curr. Microbiol. App. Sci.	9(9): 1371- 1381, 2020

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22	Naik, B.V., Patil, S.V., Shirdhankar, M.M., Yadav, B.M., Tibile, R.M. , Chaudhari, K.J., Wasave, S.M., Yewale, V.G.	Information source utilization among shrimp farmers of South-Konkan region, Maharashtra, India	Contemporary Research in India	10(3): 24-27, 2020
23	Naik, B.V., Patil, S.V., Shirdhankar, M.M., Yadav, B.M., Tibile, R.M. , Chaudhari, K.J., Wasave, S.M., Yewale, V.G.	Shrimp farming sector in South Konkan region, Maharashtra: A constraint analysis	Journal of Entomology and Zoology Studies	8(5): 356-359.
24	K. S. Sawant, S. J. Meshram, H. B. Dhamagaye, B. R. Chavan, R. M. Tibile and V. R. Vartak	Growth and survival of <i>Labeo rohita</i> (Hamilton, 1822) fry in biofloc system using various dietary protein levels	J. Exp. Zool. India	23, Supplement 1: 765-769, 2020
25	N.S. Sawant, D.I. Pathan, A.S. Pawase, R.M. Tibile and P. S. Desai	Effect of filter media on survival and growth of <i>Macrobrachium rosenbergii</i> larvae in artificial seawater recirculation system	Bioinfolet	17 (1A): 18 - 23, 2020
26	Sawant NS, Pathan DI, Pawase AS, Tibile RM and Desai PS	Maturation of different filter media using culture water	Journal of Entomology and Zoology Studies	8(1): 63-68, 2020
27	A. S. Kute, R. M. Tibile1, A. S. Pawase, G. S. Ghode, M. F. Ghuguskar, K. S. Sawant, R. P. Waghmode and S. S. Dey	Growth and survival of rohu, <i>Labeo rohita</i> (Hamilton, 1822) fry using different carbon sources in biofloc system	J. Exp. Zool. India	25 (2): 1503-1510, 2022
28	Dey, S.S., Tibile, R.M., Pawase, A.S., Meshram, S.J., Pathan, D.I., Nayak, A.	Evaluation of different stocking densities and carbon:nitrogen ratios on growth, body composition and production performance of <i>Labeo rohita</i> (Hamilton, 1822) spawn in biofloc based-nursery	Aquaculture Research	53 (14): 4989-5005, 2022

		system		
29	Raju M. Tibile, Gajanan S Ghode and Ravindra A. Pawar	Pre- and post-spawning condition descriptors for the Indian major carp, <i>Cirrhinus mrigala</i>	Indian Journal of Animal Sciences	92 (11): 1368–1371, 2022

6. Publications of Dr. S. S. Wasave

	Author/s	Title of the paper	Journal	Volume/year
Name of staff member: Mrs. S.S. Wasave				
1.	Wasave, Sangita S., Wasave Suhas M., Singh H., Yadav Bharat M. and Yadav Rakesh P.	Ingredients used in aqua feed formulation in India.	<i>Fishing Chimes Vol. 29 No. 8</i>	2009 : 52 - 55
2.	S. M. Wasave, S. S. Wasave , B. M. Yadav and S. V. Patil	Mangrove - A boon to ecology – Needs conservation	<i>Ecology and Fisheries Vol. 3 (1)</i>	2010 : 107 - 112
3	Yadav, R. P, S. T. Sharangdhar, M. T. Sharangdhar, S. M. Wasave, S. S. Wasave and H. S. Patil	Utilization of brown seaweed <i>sargassum</i> for preparation of soup, from seaweed soup powder.	<i>Ecology, Environment and Conservation. Vol. 16(2)</i>	2010 : 163 – 168
4	Yadav, R. P, S. T. Sharangdhar, M. T. Sharangdhar, S. M. Wasave and S. S. Wasave	Utilization of brown seaweed <i>sargassum</i> for preparation of soup	<i>Ecology, Environment and Conservation. Vol. 16(2)</i>	2010 : 169 – 174
5.	Wasave Sangita Suhas , Hukum Singh, Wasave Suhas Mahadeo and Yadav Bharat Mahadeo	Bioenergetics of the cashew (<i>Anacardium occidentale</i> L.) testa powder incorporated diet for the post larvae of <i>Macrobrachium rosenbergii</i>	<i>The Asian Journal of Animal Science. Vol.6, Issue 2</i>	December 2011 : 153 - 158
6.	Gawade Mangesh Mohan, Wasave Suhas Mahadeo, Wasave Sangita Suhas , Yadav Bharat Mahadev, Patil Sandesh Vitthal and Patil Sayali Sandesh	Rearing of Asian seabass, <i>Lates calcarifer</i> (Bloch, 1790) fry to fingerlings in cages	<i>Geobios. Vol. 39 (1)</i>	2012 : 13 – 16
7	Wasave S. S., H. Singh and Wasave S. M.	Bioenergetics parameters of the diet designed for post larvae of <i>Macrobrachium rosenbergii</i> (DeMan 1879) by partial replacement of	<i>Journal of Aquaculture in the Tropics Vol.26 (1-2)</i>	2011:71-78

		fishmeal with Jackfruit (<i>Artocarpus heterophyllus</i>) seed powder		
8.	Wasave Suhas M., Wasave Sangita S. , Dagare Rajesh A., Yadav Rakesh P. and Murkar, Anup A.	Tricks to Breed Oscar fish	<i>Fishing Chimes</i>	2011: 48 – 52 Vol. 31 No. 9
9	S. V. Patil, S. S. Sawant, S. M. Wasave, B. M Yadav, S. S. Patil, M. J. Gitte, and S. S. Wasave	Mangrove Ecosystem : Importance, Threats and Conservation	<i>Fishing Chimes Vol. 33 No. 1&2</i>	2013: 150-15
10	S. M. Wasave, S. S. Wasave , S. S. Sawant, B. M. Yadav and S. V. Patil	Wildlife protection acts for conservation of endangered marine organisms in India	<i>Ecology, Environment and Conservation. 20 (1)</i>	2014 : 195 - 201
11	S. M. Wasave, Arpita Sharma and Sangita Wasave	A Glance of Fishermen's Cooperative Societies of various Countries around the Globe	<i>Journal of Extension Systems Vol. 31</i>	2015:
12	Suhas Wasave, Arpita Sharma, Kiran Kokate, Samar Datta, Shekhar Ojha, Asha Landge and Sangita Wasave	Participation of Marine Fisheries Cooperatives in Social Development of fisher community	Indian Journal of Ecology, Vol. 44(1):124-129	2017
13	Suhas Wasave, Arpita Sharma and Sangita Wasave	Case study of Marine Fisheries Cooperative Societies in village Versova-Mumbai of Maharashtra State, India	Indian Journal of Social Research. Vol. 59(2): 265-276	2018
14	Suhas Wasave, Arpita Sharma, Sangita Wasave	Socio-economics and marketing approach of fish retailers of Ratnagiri area,	Contemporary Research in India, Special Issue 9 th – 10 th February, 2018 : 125-130	2018
15	Wasave SS , H Singh and Wasave SM	Cashew nut Anacardium occidentale L. byproducts as an alternative protein source for post-larvae	Journal of Entomology and Zoology Studies 2019; 7(5): 30-35	2019

		of <i>Macrobrachium rosenbergii</i> (de Man, 1879)		
1 6	S. S. Wasave , B. R. Chavan, S. D. Naik, S. M. Wasave, A. S. Pawase, R. M. Tibile, G. S. Ghode, S. J. Meshram and V. S. Shivalkar	Role of microbes in biofloc systems : A review	J. Exp. Zool. India Vol. 23, Supplement 1, pp. 903-906,	2020
1 7	J. K. Hire, S. S. Wasave* , R. Pai, S. J. Meshram, G. S. Ghode, S. S. Sawant and S. M. Wasave	Effect of probiotic, <i>Bacillus Spp.</i> enriched artemia on growth of Gold fish, <i>Carassius auratus</i> (Linnaeus, 1758) Larvae	J. Exp. Zool. India Vol. 23, Supplement 1, pp. 741-745,	2020
1 8	Suhas Wasave, Arpita Sharma and Sangita Wasave	Organizational roles performed by marine fisheries cooperatives of Maharashtra State, India	J. Exp. Zool. India Vol. 23, Supplement 1, pp. 781-786, 2020	2020
1 9	Wasave SS , Chavan BR, Pawase AS, Shirdhankar MM, Mohite AS, Pai R, Wasave SM and Naik SD	Growth performance of GIFT tilapia (<i>Oreochromis niloticus</i>) fry in biofloc system using different carbon sources	International Journal of Fisheries and Aquatic Studies 2020; 8(4): 206-211	2020
2 0	D. N. Toraskar, S. M. Wasave, M. M. Shirdhankar, K. J. Chaudhari, S. S. Sawant, S. S. Wasawe and A. B. Salunkhe	Socio-economic status of Rampan operators of Sindhudurg district of Maharashtra	J. Exp. Zool. India Vol. 23, Supplement 1, pp. 787-791	2020
2 1	Salunkhe AB, Wasave SM, Shirdhankar MM, Chaudhari KJ, Sawant MS, Wasave SS , Yadav BM, Patil SV and Toraskar DN	Adoption of recommended farming practices by shrimp farmers in north Konkan region of Maharashtra, India	Journal of Pharmacognosy and Phytochemistry; Sp 9(5): 133-137	2020
2 2	Wasave SS , Chavan BR, Pawase AS, Shirdhankar MM, Mohite AS, Pai R and Wasave SM	Effect of carbon sources and water requirement in rearing of genetically improved farmed tilapia (<i>Oreochromis niloticus</i>) fry in biofloc system	Journal of Entomology and Zoology Studies. 8(5): 1361-1365	2020
2 3	Suhas Wasave, Sangita Wasave, Ketankumar	Knowledge, Awareness, and	PLoS ONE 16 (12)	2021

	Chaudhari, Prakash Shingare, Bharat Yadav, Sandesh Patil, Bhalchandra Naik	Practices (KAP) towards COVID-19 among the marine fishers of Maharashtra State of India: An online cross sectional Analysis	https://doi.org/ 10.1371/journal.pone.0261055	
2 4	Suhas Wasave, Arpita Sharma and Sangita Wasave	Consensus Based Assessment of Constraints Faced by Marine Fisheries Cooperative Societies in Maharashtra, India	Indian Journal of Extension Education Vol. 57, No. 3, 2021 (125- 131) DOI: 10.5958/2454- 552X.2021.00 132.8	2021

7. Publications - Dr. Varsha R. Bhatkar

Title of the research paper	Authors	Journal /Vol. No/Page No.	Year of publication
Evaluation of different live foods on growth and survival of sea horse fish, <i>Hippocampus kuda</i> ponies.	Dhamagaye, H. B., Chogale, N. D., Bondre, R. D., Bhatkar, V. R.; 2007.	Asian Fisheries Science 20 (2007):1-6	2007
Evaluation of some formulated diets for rearing of fry of rabbit fish, <i>Siganus canaliculatus</i> .	Bhatkar, V. R., Bondre, R. D., Dhamagayr, H. B., Chogale, N. D., Bhosale, B. P.,	AQUACULT Vol. I (2),269 -273, 2007. IssN - 0972 2/62	2007
Biochemical and organoleptic changes of fish ball in curry prepared from <i>Catla catla</i> and stored at - 18 ⁰ C	Kolekar,A. D. Pagarkar, A. U., Kedar, J. G., Baug, T. E. and Bhatkar, V. R.	Ecosystem environment and conservation 19(2);pp (391-394)(ISSN No. 0971-765 X Print)	2009

7. Publications of Mrs. A. N. Sawant

Sr. No.	Author/s	Title of the paper	Journal	Volume, Page
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				number, year
1.	A. B. Funde, S D. Naik, A. S. Pawar and R.K. Sadawarte	The mudcrabs (Family: Portunidae) of the South Konkan coast of Maharashtra, India	Ecology, Environment and Conservation	Vol.19(3); pp. 725-730, 2013
2.	A. B. Funde, S. D. Naik, A. S. Pawar and S. P. Hotekar	Comparative efficiency of Mudcrab fishing methods in and around Ratnagiri, Maharashtra	Aquacult	Vol. 14 (1 & 2); pp. 25-34, 2013
3.	S. D. Naik, H. B. Dhamagaye, A. N. Sawant and S. P. Hotekar	Backyard hatchery operation for seed production of Mudcrab, <i>Scylla tranquebarica</i>	Global Journal of Multidisciplinary studies,	Vol. 4 (12); pp. 405-412, 2015
4.	S.B. Satam, V.R. Sadawarte, A. N. Sawant , N.D. Chogale, S.Y. Metar and B.R. Chavan	Ornamental fish biodiversity in Mirya creek of Ratnagiri	Ecology and Fisheries	Vol.8 (1); pp. 32-36, 2015
5.	V.R. Sadawarte, R.K. Sadawarte, H.S. Dhaker, A. N. Sawant and M.T. Sharangahar	Effect of ethinylestradiol on growth and survival of Black tetra, <i>Gymnocorymbus ternetzi</i> (Boulenger, 1895)	Journal of Experimental Zoology, India	Vol.19(2); pp. 991-994, 2016
6.	V.R. Sadawarte, H.S. Dhaker, R.K. Sadawarte, A. N. Sawant , P.C. Lokhande, S.B. Satam and S.S. Sawate	Effect of methyltestosteron on growth and survival of Black tetra, <i>Gymnocorymbus ternetzi</i> (Boulenger, 1895)	Journal of Experimental Zoology, India	Vol.19(2); pp. 1051-1054, 2016
7.	A. N. Sawant , N.D. Chogale, V.R. Sadawarte, S.Y. Metar, S.B. Satam, K.M. Shinde, A.U. Pagarkar and H. Singh	Growing ornamental aquatic plants as a small scale industry to rural livelihood	Contemporary Research in India	pp. 122-125, 2018
8.	N. D. Chogale, B. R. Chavan, V. R. Sadawarte, R. Pai, A. U. Pagarkar, S. Y. Metar,	Production of <i>Chaetoceros calcitrans</i> in Different Nutritive Condition in Shrimp Hatchery, Wadamirya,	Contemporary Research in India	pp. 52-56, 2018

	S. B. Satam, K. M. Shinde, A. N. Sawant and H. Sing	Ratnagiri		
9.	S. B. Satam , N. H. Sawant , M. M. Ghughuskar , V. D. Sahastrabuddhe, V. V. Naik, A. U. Pagarkar , N. D. Chogale , S. Y. Metar , K. M. Shinde, V. R. Sadawarte, A. N. Sawant , H. Singh, P. A. Sawant, V. K. Patil, A. D. Rane, P. M. Haldankar and T. Bhattacharyya	Ornamental Fisheries: A new Avenue to Supplement Farm Income	Advanced Agricultural Research & Technology Journal	Vol. II, Issue 2, 2018
10.	S. Metar , N. Chogale , K. Shinde , S. Satam , V. Sadawarte, A. Sawant , V. Nirmale , A. Pagarkar and H. Singh	Transportation of Live Marine Ornamental Fish	Advanced Agricultural Research & Technology Journal	Vol. II, Issue 2, July, 2018
11.	N. D. Chogale ¹ , A. U. Pagarkar , S. Y. Metar, S. B. Satam , V. R. Sadawarte , A. N. Sawant , K. M. Shinde and H. Singh	The role of the public aquarium of marine biological research station on raising public awareness to aquatic environment	Journal of Experimental Zoology, India	Vol. 23, pp. 919-923, 2020

Technical/ Popular Articles :

6. **Details of other activities (for e.g. seed production, production of other commodities etc):** Ornamental fishes are reared in wet laboratory under revolving funded project.

7. **Contact Information**

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